THE

ELECTRICAL REVIEW.

VOL. XCI. NOVEMBER 17, 1922. No. 2,347.

JUBILEE ISSUE.

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THE

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LOOKING FORWARD.

"This is our programme. Experience may prove modification to be desirable, and we shall gladly profit by the teachings of experience. But there will be no change in, or modification of, the tone of the JOURNAL, *or the determination to overcome any opposition that may present itself.*

Thus, then, the ropes are severed, and there is launched into the waters of scientific literature a new barque—named THE TELEGRAPHIC JOURNAL."

Vol. I, No. 1, November 15th, 1872.

WITH the above sentences the founders of the ELECTRICAL REVIEW closed the statement of their intentions as to purpose and policy, issued on the first page of the first volume of this publication. In the course of the programme referred to, they mentioned that "while applied sciences of far less extent have several representatives in periodical literature, the applications of electricity have no special organ." The "independence" of the new Journal was made an outstanding feature in its policy, and "the only authority tolerated in these pages" was to be "born of right and reason," while "impartiality" was also "to characterise the Journal."

Those who launched out in the new enterprise were men of foresight, who, though they had settled the details of a well-thought-out programme, were not devoid of the virtue of adaptability, but were prepared to adopt modifications when experience proved such to be desirable. We and others to whom the honour of succeeding them has fallen, have humbly endeavoured to fulfil our functions under the influence of the lofty traditions and high principles which were our heritage. Under the changing conditions of journalistic life, our independence and impartiality have been put to the test, and, like the founders themselves, we have frequently seen the necessity for standing discreetly on our guard prepared for any eventualities, determined to "overcome any opposition" which was designed to harm either the interests of the electrical profession, or those of the journal which was destined to record the developments of electrical research and electrical applications. It is there, too, that we stand to-day.

Half a century has passed since that programme was prepared. We do not need to prepare programmes to-day, for as the years have flown the multifarious advances that have led electricity from its infancy to its gianthood have indicated the needs for adaptability in regard to the contents of the paper, so that to-day we are able to review in some form every week the progress taking place in all departments of electrical activity; indeed, the contents of each issue of the ELECTRICAL REVIEW have almost entirely to be dictated by the course of events. To our keen regret, during the past eight years we have had temporarily to come short of our best ideals and anticipations, but when one compares the ELECTRICAL REVIEW of November, 1922, with that of November, 1872, one is impressed with the fact that features which fifty years ago were regarded as important are found to be so still. As our readers and the trade are aware, we endeavour to make every weekly issue of the ELECTRICAL REVIEW complete in itself. Special issues are a luxury in which we prefer not to indulge unless there is some quite unusual circumstance justifying them. The largest number of the REVIEW that has ever appeared until to-day was that published on the occasion of our Twenty-fifth Birthday in 1897, when a number of eminent experts contributed a series of articles on the technical developments of a quarter of a century in the departments of electrical activity of which they had made a special study. Early in the present year the Institution of Electrical Engineers held its very successful Jubilee celebrations, when every branch of electrical science and application was alluded to in detail by one or other of the speakers. Inasmuch as the ground to be covered now, if we were to set ourselves a like task, would inevitably be very similar, in view of the fact that the REVIEW volumes have contained the continuous record of all that has happened, we have preferred, in issuing this Special Number of the REVIEW to commemorate our Jubilee (it was exactly fifty years on Wednesday since the REVIEW first appeared), not to indulge too fully in retrospection. Instead, we have chosen to adopt the attitude of men who are looking forward—not forgetting the greatness of the electrical achievements of the past, but pushing onward, as it were, into the future of dazzling brilliance to see what great things are in store as present signs and promises come to their period of fulfilment in the Electrical Age that now is at its dawn.

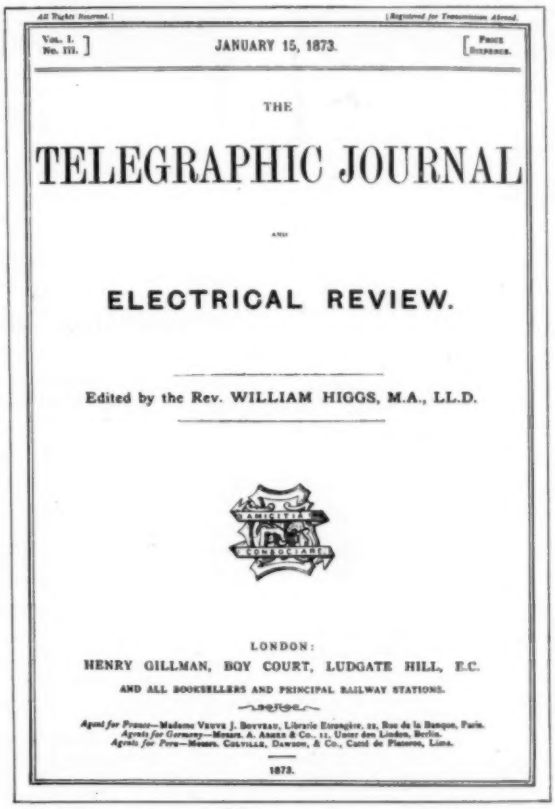
We are under deep obligations to the many writers who have so kindly co-operated with us in the production of this Special Issue. The articles and other communications contributed by them will, we are sure, meet with a cordial reception from our many thousands of readers at home and abroad.

The series of letters that have reached us from many of the organisations whose interests we have endeavoured to promote and safeguard in some way or other are particularly welcome and gratifying. Such communications serve to remind us that in our weekly contributions to electrical literature we are either reflecting or influencing the opinions and the operations of many thousands of men in all departments of electrical activity, throughout the entire civilised world. We hope to continue the faithful discharge of our responsibility, maintaining the deeply rooted principles of the REVIEW in a spirit of optimism and of adaptability. Practically all those who were interested in electrical science when "the ropes were severed" and this journal was launched, as well as a large number of their successors who have figured in the galaxy of contributors to these pages, have passed on into the Solution of the Mysteries. Not many of us who are in the thick of electrical affairs to-day will remain this side of that doorway when the ELECTRICAL REVIEW celebrates its hundredth anniversary, but whatever marvels and changes may lie in store, those who follow will always, if they are men of sound sense and foresight, find it desirable to "profit by the teachings of experience," and to modify their programmes in such a way as to keep in step with progressive development.

OUR FIFTY YEARS.

In the year 1897 one of our American electrical contemporaries (since absorbed) conducted an inquiry into the priority of electrical journals published in the United Kingdom, and we were privileged to print the result of that inquiry, together with communications from two well-known and highly-esteemed electrical authorities of those days—Thomas D. Lockwood, of Boston, and Desmond G. Fitz-Gerald (one of the founders, and the first editor, of the *Electrician* of 1861). As the Electrical Review has now completed fifty years' continuous existence, we have thought that at least some of our readers would be interested in the true record of the respective events and circumstances of our very early days. We therefore reproduce the following from our issue of June 18th, 1897, p. 838, together with the illustrated headings which appeared on the first and third numbers — November 15th, 1872, and January 15th, 1873. In the former heading it will be seen that the word "Review" of electrical science was used right from the beginning, while the sub-title "Electrical Review" was definitely adopted in the third issue from its birth. The progress of electrical science and practice led to the abandonment of the words "Telegraphic Journal" nineteen years later—on January 1st, 1892—since when "The Electrical Review" has been our only title.

We believe that the foregoing notes and the following reprint will satisfy the inquiring minds of most of our readers, but in case there are any who, in the interests of veracity and good fellowship, ought to know the facts, but do not, yet are desirous of so doing, we would add that a complete set of bound volumes of this Review from Vol. 1 to Vol. 91 (ended June, 1922) stands on the shelves of our Editorial Department, and can be inspected by appointment.



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Vol. I. No. III.] JANUARY 15, 1873. [Price Sixpence.

THE

TELEGRAPHIC JOURNAL

AND

ELECTRICAL REVIEW.

Edited by the Rev. WILLIAM HIGGS, M.A., LL.D.

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1873.

The Cover of the Journal fifty years ago was pale blue in colour as it is to-day. The size of page was 9¼" × 6¼"

ENGLISH ELECTRICAL JOURNALS.

[*Reprinted from* Electrical Review, *June 18th, 1897, p. 838.*]

On May 1st of this year the *Western Electrician*, of Chicago, contained the following:—

Name of Journal.	Date of issue from which information is obtained.	Self-designation as to age.	No. of Vol.	Total No.
Electrical Review.	April 16, 1897	The oldest weekly electrical paper. Established 1872.	XL.	1,012
Electrician.	April 16, 1897	The oldest electrical journal (established as a weekly journal, 1861-1878).	XXXVIII.	987

The Electrical Review, of London, had occasion recently to felicitate itself on the publication of its 1,001st number. It commenced publication in 1872, "when no other electrical paper now appearing was in existence," and soon developed into a semi-monthly, coming out as a weekly 15 years ago. This quarter-century's record of progress shows very creditable achievement, and we extend our congratulations.

The anniversary serves, however, to direct attention to the curious fact that America has no monopoly of the disagreement regarding the priority of electrical journals. But there is the difference that while in the United States there are three claimants to the doubtful honour, in England, so far as we are aware, there are only two aspirants—the one named, and our esteemed contemporary, the *Electrician*. The subject has interested us sufficiently to induce us to collect the salient facts in the British case in the form of the accompanying table. . . . . Our hope is simply to see an important scientific inquiry carried to a satisfactory and authoritative conclusion.

As the honour and truthfulness of this paper seems to be called, with that of a contemporary, into question, we may be excused for republishing replies which the above publication called forth.

We claim no virtue in age alone, and should therefore have allowed the matter to rest with our Chicago contemporary; but the two considerations mentioned above demand that the independent evidence forthcoming in the following letters, the one from the United States and the other from London, should be reproduced.

English Electrical Journals.

To the Editor of the *Western Electrician*.

I observe that on page 246 of your last issue you have an article referring to the relative ages of your two British contemporaries, the Electrical Review and the *Electrician*, both of London. In view of the apparently conflicting statements which have been made it is not surprising that the question, Which of the two was the first journal to appear? is something of an enigma.

I happen to possess the first volume of both, and can give you the facts. The Electrical Review appeared first as the Telegraphic Journal and Electrical Review in 1872, No. 1 of Vol. I bearing the date of November 15th, 1872, and as the consecutive numbers of the volumes and issues have been carried on up to the present time, there can, I conceive, be no question that this journal is entitled to its claim that the present Electrical Review is in fact the same journal as that which originally bore the double name of the Telegraphic Journal and Electrical Review. No one would dare to say that a man has changed his identity because in his mature life he may have chosen to drop one of the several Christian names given to him by "godfathers and godmothers in baptism."

The *Electrician* does not go farther back than 1878. No. 1. Vol. I, of that publication, is dated May 25th, 1878; and every editorial line of that issue shows that it considers itself to be the first of its race. Its prospectus begins as follows:—"The want of a weekly paper devoted to the consideration of electrical subjects has long been felt, and we venture to attempt to supply the want." And the same suggestion, differently stated, is also to be found at the beginning of the first leading article on page 6.

It is true that a number of years prior to this—that is, in the early sixties—there had already been a weekly journal bearing the same title, viz., the *Electrician*, but this had gone out of existence long before, and certainly the present journal cannot by any sensible person be regarded as a continuation of the earlier *Electrician*, which had lived an ephemeral life, and had passed totally out of existence.

I have never been able to obtain a copy of this earlier paper, but think that I have seen somewhere a statement that it started in 1861, and did not exist more than two or three years at the outside. It is mentioned in the celebrated Ronald's

Catalogue of electrical books as "*Electrician*, The. A weekly journal of telegraphy, electricity, &c. 4to. London, 1862."

THOMAS D. LOCKWOOD.

Boston, *April 30th*, 1897.

ENGLISH ELECTRICAL JOURNALS.

To the Editor of the *Western Electrician*.

My attention has been directed to a paragraph in your issue of the 1st inst, referring to the London ELECTRICAL REVIEW.

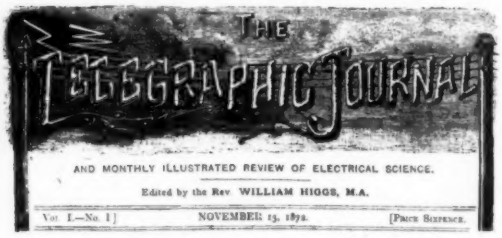
The "puzzling questions" you propound are the very natural outcome of a *suggestio falsi*—intentional or otherwise—by which you have been misled.

In the interval between May, 1864, and May, 1878, there was no *Electrician*. In November, 1872, the ELECTRICAL REVIEW was started, in the first instance as a monthly paper. In 1878, when the *Electrician* was re-started—I will not say resuscitated—the former paper was a fortnightly one.

It would not be strictly correct to say that the new issue of the *Electrician*, under the auspices of the late Sir John (then Mr.) Pender and the late Sir James Anderson, was a continuation of the old paper founded by the late Owen Rowland and myself and edited by me, although my consent to the use of the title was, as a matter of form, applied for and given. Like the present ELECTRICAL REVIEW, the old *Electrician*, "such as it was and what there was of it," was entirely independent of any financial control or trade influences. Had it been otherwise, perhaps the awkward hiatus of 14 years would not have occurred.

DESMOND G. FITZ-GERALD.

London, *May 14th*, 1897.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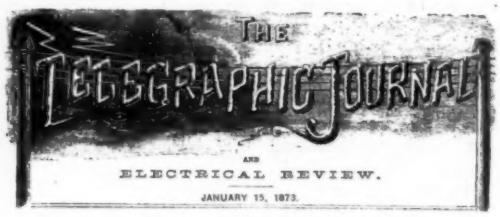
Vol. I.—No. 1] NOVEMBER 15, 1872. [PRICE SIXPENCE.



Headings of First Editorial page in Nos. 1 and 3 of this Journal showing the alteration of wording of sub-title two months after the foundation of the paper.

SOME "REVIEW" DATES.

November 15th, 1872.—"The Telegraphic Journal and Monthly Illustrated Review of Electrical Science" first appeared. Price sixpence. It contained 18 small pages of editorial matter and 6 pages of advertisements.

January 15th, 1873.—The title was altered to "The Telegraphic Journal and Electrical Review."

May 15th, 1873.—"In answer to the increasing demand," the Journal was issued fortnightly instead of monthly, and the price was reduced to fourpence.

Early in 1874.—Mr. H. Alabaster (to-day Chairman and Managing Director of the Electrical Review, Ltd.) became interested in the paper as a proprietor. His connection with it has been continuous down to date, that is, for nearly 49 of its 50 years.

1881.—Mr. T. E. Gatehouse became editor of the ELECTRICAL REVIEW, and continued as "Chief" until his death in March, 1921.

1882.—With the issue of January 7th, 1882 (Vol. X) the REVIEW became a weekly paper, and the size of page was enlarged from 9¾ in. x 6¾ in. to what it is to-day.

1883.—The partnership of H. Alabaster, Gatehouse & Co. was formed; for a short time the title of the firm was altered to H. Alabaster, Gatehouse & Kempe; in 1919 the business was converted into a limited liability company—"The Electrical Review," Ltd.

1891.—The words "Telegraphic Journal" were abandoned entirely, and the title "Electrical Review" alone was retained.

In February, 1893, the first of the series of costly actions between the proprietors of the ELECTRICAL REVIEW, Dr. Tibbitts, and the Medical Battery Co., Ltd. (Harness electropathic belts), were fought in the High Courts of Justice. From first to last the verdicts were in our favour.

1897.—On November 12th, we published a Special Issue to celebrate our 25th Birthday.

1912.—On November 15th we celebrated our 40th Birthday.

1922.—November 17th. Jubilee Issue of the ELECTRICAL REVIEW appears.

ADVERTISERS OF FIFTY YEARS AGO.

THE following are the names of advertisers who had announcements appearing in the first two issues of the ELECTRICAL REVIEW, November and December, 1872:—

LOCKWOOD & CO. ...	... Publishers.
BLACKIE & SON ...	... Publishers.
MACMILLAN & CO. ...	... Publishers.
LONGMANS, GREEN & CO.	... Publishers.
HORATIO YEATES ...	... Instrument makers.
BRITISH TELEGRAPH MANUFACTORY	Magneto-electric counters and magneto-electric bells.
J. & W. RICKARD ...	... Insulated electric wires.
JOHN BROWNING ...	... Instrument maker.
THOS. FLETCHER ...	... Gas furnaces.
W. LADD & CO. ...	... Instrument makers.
JOHN FAULKNER ...	... Lightning conductors, private telegraphs and electric bells.
WALTER HALL	... Telegraph contractor and manufacturer.
INDIA-RUBBER, GUTTA-PERCHA AND TELEGRAPH WORKS CO., LTD.	India-rubber, ebonite, gutta-percha, telegraph instruments, insulated wires, batteries, &c.
W. M. FOXCROFT'S TELEGRAPH CASE MANUFACTORY	Telegraph instrument cases.
FRANCIS & CO. ...	... Telegraph engineers.

The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd., have been the most regular advertisers in the REVIEW from its first issue.

In 1874 there appeared an advertisement of Messrs. H. A. Harborow & H. Spagnoletti, electric telegraph engineers, contractors, and manufacturers, Marylebone, W. The Park Royal Engineering Works, Ltd., Park Royal, London, N.W.10, who have an advertisement in the present issue of the REVIEW, are the successors of that firm, which was in business as far back as 1851.

Messrs. J. & W. Rickard, mentioned above as advertisers in the first volume, will be recognised as the Macintosh Cable Co., who are among our regular advertisers to-day.

The business of Mr. M. Selig, Junior, also an advertiser in the first volume, subsequently became known as Selig, Sonnenthal & Co., and is now the Selson Engineering Co.

Messrs. Julius Sax & Co. were advertising in the REVIEW in February, 1873, as Julius Sax, 108, Great Russell Street, W.C., telegraph, magnetic and electrical instrument manufacturer. Mr. Sax, who came to England in 1851, was manufacturing instruments here in 1855 when the present business was established, and in 1863 he turned his attention to domestic telegraphy.

MESSAGES FROM MANY QUARTERS.

Lord Riddell

(President, Weekly Newspaper and Periodical Proprietors' Association).

Hearty congratulations to the Electrical Review on its fiftieth birthday! Experts tell me, and I can well believe, that it owes its proud position to the accuracy of its information and the sagacity of its policy. Needless to say, it has rendered invaluable services to the fascinating industry which it represents—an industry which has witnessed in the course of the past half-century more changes and developments than any other. During the war the Electrical Review placed the whole of its staff, organisation, and accumulation of technical knowledge at the disposal of the Government. As chairman of the Weekly Newspaper and Periodical Proprietors' Association, of which the Electrical Review is a member, I had exceptional opportunities of realising the value of the help thus furnished and the importance attached to it by the public departments concerned. I hope most sincerely that the paper will continue to flourish, and that its centenary will be celebrated in due course. A message of congratulation from me on that occasion will, however, be out of the question unless rendered possible by some new invention which will no doubt be heralded in the Electrical Review!

Mr. Frank Gill

(The President, The Institution of Electrical Engineers.)

Electrical engineers throughout the world, and throughout the British Empire in particular, owe a great deal to the Electrical Review for the fifty years' faithful service it has rendered to the profession and industry. Starting with the very early beginnings of electrical engineering, it has kept its readers abreast of progress and has earned the admiration and gratitude of all. The Review is much to be congratulated on the position it has attained as the result of its own consistent merits, both in the reports it presents and in the opinions it expresses, and all who know it must wish it a further prosperous period in the future. Among these good wishes none come with greater sincerity than do those from the Council of the Institution of Electrical Engineers.

The British Engineers' Association

(Neville G. Gwynne, *President*; D. A. Bremner, *Director*).

The Electrical Review, on its fiftieth birthday, is in the happy position of being able to rely, with confidence, on its record of continuous valuable service to the electrical and allied industries for eloquent testimony of its worth. It is, however, a real pleasure to us to place on record our high appreciation of the friendly relations which have long existed between the Electrical Review and the British Engineers' Association.

Our Association has often enjoyed the hospitality of your columns, and, on several important occasions, our efforts to serve the interests of British engineering industry have received your valuable support.

We trust that the enlightened and patriotic policy of the Electrical Review may long continue to promote and safeguard the interests of British engineers.

Mr. H. Marryat

(President of the Electrical Contractors' Association, Inc.)

It is with very great pleasure that I, as President of the Electrical Contractors' Association, hand you the enclosed copy of a resolution passed at the Council meeting on October 16th, 1922. This resolution speaks for itself as to the high standing of your Journal in the opinion of my Association.

Personally I, like many other members, shall always have more than a practical interest in the Electrical Review. It has been a friend in difficult times: it has helped us to find employment and business and has pointed out what are the good and what are the bad roads to follow. In looking back over the best part of a lifetime I may safely say that the Electrical Review stands out signally at many of the turnings taken.

(Extract from Council Minutes of the E.C.A., held on October 16th, 1922.)

That this Association does heartily congratulate the Electrical Review upon the completion of 50 years of publication, during which period it has rendered incalculable service to the industry by its fearless exposure of imposture, its support of legitimate enterprise, and its encouragement of goodwill and fair trading conditions. That the thanks of the Association be tendered to the Electrical Review for the part it took in the foundation of this Association in 1901 and its subsequent support which has contributed substantiallly to the present strong position and acknowledged status of the Electrical Contractors' Association.

Mr. Donald S. Munro

(President, Electrical Contractors' Association of Scotland).

The Electrical Contractors' Association of Scotland congratulates the Electrical Review on the completion of its first half century. The journal, since its commencement, has been an inspiration to the industry, and this section of its contractor readers welcomes the occasion to express gratitude and esteem.

Lt.-Col. W. A. Vignoles, D.S.O.

(President, I.M.E.A.).

On behalf of the Incorporated Municipal Electrical Association, may I congratulate you on the completion of 50 years' continuous service to the electrical industry. This industry continually impresses me with its energy, and anxiety for progress, and this anxiety is reflected in the number of matters which are thrust upon the President of the I.M.E.A., all of which must be dealt with, in the opinion of those putting them forward, as matters of urgency.

Every section of the industry appears to share this desire to move forward, and the hearty co-operation with the I.M.E.A. of such Associations as the B.E.S.A., the E.D.A., the B.E.A.M.A., and the E.C.A., together with the firm and sane backing of the electrical Press, is a sure promise that the rapid progress in the last few years will be maintained.

The Electrical Review has contributed fully to this progress, and I feel sure that, with its traditions, in the years to come it will do even more for the industry than it has done in the past.

Mr. F. B. O. Hawes

(Hon. Sec., Electrical Trades Benevolent Institution.)

The fact that the Electrical Review is about to celebrate the completion of fifty years' continuous service, comes as a reminder of the rapidity with which time is flying, as the first occasion of my having the pleasure of reading it took place when your paper was considerably less than ten years old. Since then I have been a comparatively regular reader of it, and am pleased to express to you my appreciation of the valuable assistance it has been to the electrical industry.

In the above I write as the ordinary reader, but as Hon. Secretary of the Electrical Trades Benevolent Institution I have had opportunities of appreciating more intimately the breadth of view taken by the Electrical Review as evinced by the very great interest you have taken in that Institution and the very great help, both directly and indirectly, which you have given to it.

I must not omit to refer also to the late Mr. T. E. Gatehouse, whose personal friendship was greatly valued by me, and whose sound advice on many subjects I often used to obtain, with great advantage to myself and others. The straightforward and honest way in which he always dealt with matters, laid a solid foundation on which I hope the Electrical Review will always stand firm.

Mr. J. W. Beauchamp

(Director and Secretary, The British Electrical Development Association, Inc.)

On the occasion of your Jubilee Issue may I ask you to accept the congratulations of one of the youngest associations of the electrical industry? In doing this on behalf of the E.D.A. I would offer its grateful thanks for the assistance received from the Electrical Review in the last three years, and venture to hope that in the activities of this association you may see the logical outcome of much of your own consistent propaganda work over the last decade or so.

The call for united effort has always been a feature of the Review, its ample weekly budget of electrical news and liberal allocation of space to new enterprises and to expression of opinion by anyone interested in our great industry, have done much to secure for your journal the esteem with which it is regarded to-day.

To many of us the file copies of the Review stand as milestones along the road of progress. We have watched its advertisements for vacancies and business openings, read with appreciation its kindly references to our success from time to time, and its friendly little records of domestic events or the final passing of old comrades from the fighting line.

The pace quickens, the next few years must bring great expansion in the electrical world, change its personnel and develop its relations with the public. The increasing scope and influence of the trade journals will be a vital feature in this growth, and the past record of the Review leaves us with no doubt of the important part it is destined to play, or of the valuable help it will be able to give every member of the industry.

Mr. A. G. Beaver

(President, Electrical Wholesalers' Federation).

Fifty years is a long time comparatively speaking, and it is a matter for congratulation that the Electrical Review has, since its inception half a century ago, been able to give continuous service to the electrical industry. The past fifty years

has seen the electrical industry grow up from infancy to lusty manhood, and to-day there is hardly an industry which can be carried on efficiently without its assistance.

The Proprietors and Staff of the Review must feel especially proud at this time of the great part they are called upon to play in the large world and field of electricity. . . . . .

The Electrical Wholesalers' Federation, of which I have this year the privilege and honour to be President, was founded some eight years ago in order to take care of and co-ordinate the interests of the electrical factor and the wholesale distributor. In conjunction with other associations it has devoted a large amount of time to the elucidation and settlement of various questions of vital importance affecting the commercial side of the industry.

The chief question affecting all those engaged in the electrical industry to-day is: How to obtain and give a cheaper and better service to the public. Only by such service can the industry hope to realise that increase in business which is essential if the electrical industry is to make progress and flourish.

To this end your valued paper will, I hope, continue to extend that help in the way of publicity and other co-operative service it has so worthily given in the past.

Mr. W. J. Jeffery

(President, Electrical Power Engineers' Association.)

It gives me great pleasure on behalf of the technical staff of the electricity supply undertakings, to convey our congratulations to the Electrical Review on reaching its 50th anniversary.

One of the first things we learnt on entering the industry was the existence of a journal, on the middle pages of which we found notices which none of us could afford to neglect. Probably the first serious attempt at joint action among staff men in the industry was in the weekly purchase of the paper, which, through its middle pages, held out hopes of a more prosperous future, and in spite of every discouragement we were inspired to do our best in the hope that one of the plums, no matter how small, might fall to our lot.

Before long we realised that after all the middle pages were merely an adjunct to the more important parts of the paper—the technical articles—which kept us in touch with the latest developments in electrical work throughout the world—the personal items—which linked us with our fellow engineers—and the editorial notes which clearly indicated the sound policy of the journal. The editorial notes have invariably demonstrated that the guiding principle of the Editors has been the good of the industry. In carrying out this policy, the Editors have never hesitated to express clearly and forcibly their views on any policy or action affecting the industry, even when it has been necessary to criticise the actions of powerful interests; the fact that they have not respected persons but have considered only the common good has earned the respect of all. And those who are trying to direct the various forces at work in the industry are fortunate in knowing that an unbiased view of their actions will be expressed in the Electrical Review. We in the E.P.E.A. are glad to have the opportunity of thanking you for the interest taken in our development, and, although at times you have been severely critical of our actions, we are indebted to you for the encouragement given us at times when we were being generally misjudged.

In a more limited sphere of action we are trying to accomplish similar work to yours, *viz.*, the serving of the best interests of the electricity supply industry.

We think that it is necessary to completely organise the technical staffs, in order that we shall not be an unorganised and inarticulate group between the two organised bodies of employers and manual workers but shall instead be in the position of a group working, as far as possible, with these other groups for the efficiency, reliability, and prosperity of the industry. Our policy throughout our existence has been toward this end and though we have found our task a difficult and complicated one it has been lightened by the inspiration and encouragement which the Electrical Review has always given to us.

Mr. W. E. Highfield

(President, National Association of Supervising Electricians).

The Association of Supervising Electricians sends its heartiest congratulations to the Electrical Review on the occasion of its fiftieth anniversary. The assistance the Electrical Review has been to the electrical industry cannot be readily expressed in words, so wide has been its sphere of influence.

This Association naturally finds its main interest in the labour problems that affect its members, and holds that the conflicting interests that affect this national problem can be reconciled in a way satisfactory to all parties, and it very gladly acknowledges the great influence the Electrical Review has had on the labour world by its fearless and outspoken views on trade unionism.

The beginning of the 1922-23 session finds this Association in a strong position. Its membership has steadily increased through a very difficult period. The unemployment of its members has never exceeded 1 per cent. These good results the Association believes are due to the policy of ensuring that membership carries with it a proper qualification of craft skill, and that by thus maintaining a high standard of efficiency the needs of the Union are best served.

Mr. J. Rowan

(General Secretary, Electrical Trades Union).

In the first place we wish to congratulate the Electrical Review on the completion of fifty years' continuous publication in the best interests of the electrical industry. The Electrical Trades Union may be said to be close relations with it in the evolution of the industry, and like relations we have not always been friends, although, on the whole, we have little to complain about except that the Electrical Review has always condemned the E.T.U., whether it was right or wrong if it dared to threaten a dispute. Even this, however, we can accept as an earnest (even if we may consider it misguided) effort from a journal whose object willy-nilly is the progress of the industry, and a journal which has rarely dealt with the financial relationship between employer and employé.

We would like to take this opportunity of giving a very brief outline of the progress of the E.T.U. itself. Started in 1889, in the early days following the introduction of power and light adapted for commercial uses, our progress in the early stages was somewhat slow. This was only to be expected on account of the fact that the employés engaged were mainly unskilled, were brought into a new environment, and necessarily required training. This want of skilled workmen undoubtedly had a lot to do with the slow progress of the industry itself. Time, however, healed this by the institution of apprenticeship systems to the various crafts required in the industry. The Electrical Trades Union was the pioneer who pushed forward the necessity for apprenticeship, and as a result of its efforts was able to negotiate, not without a great deal of trouble and expense, agreed standard wages for the various sections. In the early days, the Union was confined to armature winders and electrical wiremen. In the process of evolution we have considerably extended our activities, due, of course, to the greatly extended use of electrical machinery and apparatus. As we became efficiently organised in the engineering, shipbuilding, and contracting sections, we found that if we were to become an effective organisation, we would have to deal not only with those engaged in manufacture and installation, but with those engaged in distribution, maintenance and repairs, with the result, that we extended our activities to electricity supply stations, mining, iron and steel manufacture, printing and many other industries in which electricity had ousted the more primitive forms of power. We found when we investigated the conditions, that they were not such as would attract a good class of workman. However, after a considerable amount of work, material improvements were obtained and agreed conditions established in nearly every case. The natural result has been a considerable increase in the numerical strength of the Union. Whereas at the end of 1908 it had only 1,709 members, at the end of 1914 this number had risen to 8,195, and at the end of 1920, there were no less than 57,292 members. Since that time, however, due to depression in trade, we have lost a certain number, but as this is due to unemployment and the inability of unemployed men to pay contributions, we are of the opinion that this temporary loss will be recovered and that we shall go on progressing until the trade is thoroughly organised. We are further of the opinion that the organisation of the worker is not to the detriment of the employer, as experience has shown (especially since the institution of the Whitley Councils), that it is necessary that both the employers and workmen should be organised, in order that what at first sight appear to be insurmountable difficulties may be discussed and settled. Since we have been dealing locally and nationally as organised bodies on both sides, we have found that hundreds of petty disputes have been avoided. At the time of writing, we are going through a most severe crisis. In competitive sections of the industry, such as manufacture and shipbuilding, the wages have dropped below a subsistence level, and undoubtedly cannot remain as they are, but with improvement in trade which is bound to come, we feel confident that with good sense on both sides, a more equitable standard of living will be assured to those who are engaged in one of the most important industries, and certainly the most rapidly extending one, in this or any other country.

We conclude with best wishes for the continued success of the Electrical Review.

Mr. C. Le Maistre, C.B.E.

(Secretary of the British Engineering Standards Association, and General Secretary of the I.E.C.)

The Electrical Review, in addition to its many other most useful activities, has always been a strong advocate of industrial standardisation and, at frequent intervals, has been good enough to place before its readers the general progress achieved, especially with regard to the work of electrical standardisation, which, with the hearty co-operation of the whole of the electrical industry, the B.E.S.A. is carrying on through its Sectional Electrical Committee, now under the chairmanship of Mr. C. H. Wordingham, C.B.E.

It is therefore a pleasure, on behalf of this Association, to wish the Electrical Review an even more prosperous career in the future than it has enjoyed in the past.

The dissemination of British Standards, in the work of which the Electrical Review has so cordially assisted, is indeed of the greatest importance to the trade of the coun...

for their wide adoption brings with it elimination of waste of time and material, and the technical Press is one of the most useful channels through which both purchasers and manufacturers can be informed as to the issue of new Standard Specifications and the revision of old ones.

There are still, it is to be feared, sections of the community which are not as fully aware as they should be of the basic importance of the work being carried out by this Association and of the immense value it would be to the trade of the country to mention in all contracts that unless otherwise specified, materials are to be in accordance with British Standards, where such exist. . . . .

An intensive campaign of standardisation is being carried out in many countries, and both in America and in Germany its potentialities in the building up of foreign markets are very fully appreciated and are being studied in the minutest detail.

There would appear to be a greater recognition in Germany than anywhere else of the economical value of industrial standardisation as one of the strongest weapons in the tremendous struggle towards reconstruction.

Unless, therefore, in this country industry as a whole recognises much more fully than it does at present its privileges, as well as its obligations, the work of industrial standardisation at home, as well as the dissemination of British Standards abroad in foreign languages, must of necessity fall far behind the efforts of our keen competitors and the re-building of our export trade proportionately suffer.

The activities of the ELECTRICAL REVIEW in the past justify the expectation that it will continue in the future to urge the need and the tremendous value of simplification and unification in bringing back prosperity to the country's trade.

Mr. J. W. Kirkland

(President, South African Institution of Engineers).

The South African Institution of Engineers congratulates the ELECTRICAL REVIEW on the occasion of its Golden Anniversary.

Your fifty years' of continuous publication in the interests of electrical engineering are a record of the most wonderful development in engineering conceptions and performances which has ever occurred in human history. When you started publication in 1872 there were only a few short telegraph lines in this country. It was not until 10 years had elapsed that the telegraph penetrated to the High Veld, and the electric light did not reach us until Brush arc lamps appeared on Capetown Docks in 1885 or 1886. Even in 1896, oil lamps were used in the principal buildings in Johannesburg. This letter of congratulation is no place for statistics, but your readers may be interested to know that South Africa has never been far behind in the adoption of electricity and that our electrical achievements and projects are to-day well abreast of the times. Within 25 miles of Johannesburg one may visit one of the largest steam-electric power generating systems in the world (that of the Victoria Falls and Transvaal Power Co.), which supplies practically all of the Witwatersrand gold area with light and power. In the same district can be seen in operation the largest electric winding engines ever built and the largest underground pumping station in the world—also electrically driven. The present consumption of electrical energy in the Witwatersrand district is approximately 1,000 million kWh per annum. As the total population (white and black) of the area served is only about 450,000, this represents over 2,000 kWh per head!

South Africa has always possessed the courage necessary for progress. Work is in hand for the electrification of 173 miles of main-line railway in Natal. This a section of severe mountain grades and sharp curves, and for its operation a steam-electric generating station of 36,000 kW is in course of construction. We think that no such comprehensive scheme of main-line railway electrification involving the use of coal for the generation of power has ever been undertaken elsewhere. This first great undertaking is but a beginning of what has been planned. . . . .

We hope, with you, that another half century of great invention and progress in electricity is on the horizon, and we have confidence that South Africa will seek and enjoy the great benefits which will accrue.

Mr. H. Edwards

(President, British Manufacturers' Representatives' Association of South Africa).

I very much appreciate the opportunity you have afforded me as President of the British Manufacturers' Representatives' Association of South Africa of addressing you in connection with the celebration of the fifty years' continuous publication of the ELECTRICAL REVIEW.

The chairman of the Electrical Engineering Section of this Association, which has done excellent work on behalf of British interests, informs me that the articles which have appeared in your journal from time to time, relative to electrical progress in this country, have indicated what is happening out here so fully that it would be unnecessary to contribute anything in the nature of a Press article on this occasion.

I have very much pleasure, however, in conveying to you the heartiest congratulations of members of this Association, who are representatives of electrical concerns, on the high standard maintained by your Journal throughout its long existence, and in informing you that these members are unanimous in testifying to the great usefulness of your Journal to the South African electrical world.

As an Association keenly interested in the development of all branches of British trade in this sub-continent, we trust that the ELECTRICAL REVIEW will continue to develop in the years to come to the increasing advantage of all South African representatives and merchants interested in electrical matters.

M. Philippe Bede.

(Président, Société Belge des Electriciens).

The Société Belge des Electriciens is happy to express to the ELECTRICAL REVIEW its admiration for the prosperity at which it has arrived after fifty years of incessant effort.

The ELECTRICAL REVIEW can be proud of the work which it has accomplished in the domain of science and industry, and our Association desires to offer its congratulations on the occasion of the Jubilee of the ELECTRICAL REVIEW, with cordial wishes for its continued prosperity. The field of activity open to electricians widens day by day, and we hope that your interesting journal will continue to contribute to the development of the applications of electricity in Belgium, and to maintain our present good relations with our English colleagues.

M. Brillouin.

(Président, Société Française des Electriciens).

I thank you for giving me an opportunity to write to you on the occasion of the Jubilee of your excellent ELECTRICAL REVIEW, and I will profit by the occasion by affirming that the admiration of French electricians for Lord Kelvin, Maxwell, Heaviside, Sir J. J. Thomson, and Sir E. Rutherford —to cite but a few—is still as great as ever it has been. Our two countries will do well to remember the Belgian motto, "L'Union fait la force," and put it into practice with as much firmness and loyalty during the grave difficulties of peace as during the terrible ordeal of the war. Rest assured that French electricians possess for their English colleagues sentiments of the most cordial fraternity.

Mr. Eitan Yokoyama

(Secretary, Institute of Electrical Engineers of Japan.)

We heartily congratulate you on the celebration of the fifty years' continuous publication of your journal and appreciate your great service to the public.

Mr. John H. Taylor, A.M.Inst.C.E.

(Hon. Secretary, Association of British Engineers in the Argentine Republic.)

I am desired by the Council of the Association of British Engineers in the Argentine Republic to congratulate you heartily on attaining your Jubilee in the publication of the ELECTRICAL REVIEW.

Those fifty years have witnessed remarkable progress in electrical engineering, and there can be no question that when times again become normal, we shall see still greater strides in the application of electricity to every branch of industry and particularly in its application to railways. In South America we have perhaps been a little backward in the application of electric traction to our railways, but in the production of light and power for general purposes very extensive progress has been made, much greater in fact than is generally known, and there are very few towns, even in the most remote parts, which are not lighted by electricity even if they do not boast tramways. We look to the leading technical publications to keep us in touch with current developments in the electrical world and trust that the ELECTRICAL REVIEW will continue to be a powerful factor in distributing that special knowledge to British engineers the world over.

With every good wish for success in the future.

Mr. R. S. Hilton

(Managing Director, Metropolitan-Vickers Electrical Co., Ltd.)

No doubt you will be receiving many letters expressing good will and good wishes on the occasion of your Jubilee Issue on November 17th. On behalf of my company, I should like to add our cordial congratulations and to testify to the splendid service you have rendered the electrical industry generally and British trade in particular. During a period of such unexampled progress your journal has always kept fully abreast with development or even anticipated it, and in this respect has been a stimulus to British manufacturers, which I am sure is very thoroughly appreciated. It is with this thought in my mind that I have pleasure in tendering you our best wishes for your continued prosperity.

OUR FOREIGN ELECTRICAL TRADE.

Where Britain Buys and Sells Electrical Goods and Plant.

Right from the very beginning of its career it was the policy of the Electrical Review to secure a circulation abroad keeping overseas residents who were interested in electrical science in close touch with Home sources of information and supply. Reference to the front cover used for the issue of January, 1873, which is reproduced on another page to-day, shows that at the outset agents were appointed in France, Germany, and Peru. There was very little foreign electrical trade to get in those days, but as years passed by and the world's needs and our manufacturing facilities grew, the Electrical Review devoted the necessary increased attention to the encouragement of foreign trade circulation, and more and more space in its editorial pages was devoted to the requirements of Colonial and foreign markets. It was our endeavour to retain the interest of the purchaser abroad as a reader the while we collected information overseas that should assist the British manufacturer in opening up or developing his foreign trade connections. Part of our work in this department has been the publication of articles from authorities resident abroad, and we are pleased to lay a number of such communications before our readers in this Special Issue. Another part of our activities for the commercial and industrial electrical expansion has consisted of the publication of statistical returns showing the course of trade and the extent of the competition of other countries, as reflected in trading results.

In pursuance of this policy, three tabular statements are here given which have been compiled from the official returns of the trade of the United Kingdom. Only since 1920 has electrical machinery been classified by the Customs under its various main heads. A detailed comparison with the 1913 figures is therefore impossible. Table A, however, shows the relative importance of Britain's chief markets in 1913 for electrical machinery as a whole, and in 1920 for the different types of machines. Further, the total exports in 1921 for each class are shown. With regard to exports of electrical goods and apparatus, including wires and cables, a complete comparison between 1913 and 1920 is possible, and is shown in Table B. The first column gives the total of all kinds, whilst the remaining columns give the totals of most of the principal classes. Finally, the corresponding totals for 1921 are given. It may be explained that for 1921 the statistics showing the distribution of the trade by countries are not yet published.

In Table C are shown the principal classes of foreign electrical apparatus and machinery imported into Great Britain. For 1913 and 1920, the chief countries of origin are given. For 1921 it is only possible to give the total from all countries in each class. In addition to the items shown in this table, there were imported in 1921 converters and transformers to the value of £39,000, against £8,200 in 1920; control and switchgear, £26,000 (£5,000); magnetos, £3,000 (£3,700); batteries, £83,000 (£82,000); and accumulators, £37,000 (£47,000). The total value of the imports of electrical goods and apparatus into the United Kingdom was, in 1913, £1,587,000; in 1920, £1,826,000; and in 1921, £1,931,000; whilst those of electrical machinery were £1,346,000 in 1913, £1,332,000 in 1920, and £728,000 in 1921.

Reverting to the communications that we are enabled to publish in this issue regarding the position of electrical affairs in Colonial and foreign markets, we may direct attention to the three articles on the achievements and prospects in Canada. As we have stated again and again, the Canadian market is not an easy one to tackle, but the informative views of Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario; the notes on the factors making for Canadian electrical development, written by Mr. P. T. Davies, the president of the Canadian Electrical Association; and the suggestive ideas of our Special Correspondent in Canada—all merit the most serious consideration from all who seek encouragement from the vision of overseas possibilities.

We would also commend as deserving of special study the article by our Special Correspondent in India. He refers to the prominent part played by the Electrical Review in finding new customers in India for British firms, and shows that things are moving in India in such a way that it behoves the British manufacturer to follow up the situation as revealed in Indian reports so that the chances may not be seized by others. He mentions that the German will be allowed back to India again in 1923, and that he is already laying his plans. Our correspondent, in writing to us, says.—"The average home-staying Britisher knows very little of India, and perhaps one of the surprises of an Anglo-Indian or Indian visiting England is the rank ignorance displayed on Indian matters among people who ought to know better." "This," he adds, "should be remedied if mutual business and political goodwill is to be maintained on both sides."

Professor Middleton Smith, of Hong-Kong, contributes on page 698 an article on the "Development of Electrical Engineering in the Far East," the remaining parts of which have overflowed the available space and will appear in our next issue. From South Africa, from Japan, and from the Argentine also we have received informative communications.

A.—British Electrical Machinery Exports.

—	Total electrical machinery. 1918.	Turbo-generating sets. 1920.	A.C. generators 1920.	D.C. generators 1920.	Traction motors. 1920.	Other a.c. motors. 1920.	Other d.c. motors. 1920.	Rotary converters. 1920.	Static transformers. 1920.	Control and switchgear. 1920.	Ignition magnetos. 1920.	Electrical machines. n.e.s. 1920.
	£	£	£	£	£	£	£	£	£	£	£	£
To all countries	2,269,000	187,000	107,000	262,000	49,000	412,000†	550,000‡	180,000	161,000§	188,000	45,000	525,000*
Including to												
India	293,000	50,000	17,500	70,000	12,000	88,000	210,000	42,000	16,000	81,000	11,000	164,000
Australia ...	285,000	42,000	17,000	6,000	6,000	69,000	72,000	80,000	27,000	37,000	14,000	40,000
N. Zealand ...	72,000	—	—	6,500	1,000	14,000	21,000	—	5,000	—	11,000	10,000
S. Africa ...	144,000	—	16,000	27,000	2,000	30,000	29,000	8,000	27,000	5,500	—	44,000
Spain	60,000	—	5,000	14,000	—	32,000	11,000	4,500	—	4,500	—	20,000
China	29,000	11,000	10,000	12,000	—	25,000	14,000	5,500	—	16,000	—	24,000
Japan... ...	188,000	—	—	—	—	18,000	5,000	—	—	—	—	11,000
Argentine ...	213,000	—	—	6,500	19,000	—	12,000	4,000	—	4,000	—	18,000
Brazil... ...	102,000	—	—	13,000	2,500	6,500	—	7,000	4,500	—	—	21,000
Totals, 1921 ...	4,739,000	—	459,000	474,000	195,000	1,051,000	669,000	405,000	421,000	550,000	31,000	485,000

* Total, 1920, £2,671,000. † Belgium, £25,000. ‡ Belgium, £37,000. § Belgium, £29,000.

OUR FOREIGN ELECTRICAL TRADE.—*Concluded.*

B.—British Exports of Electrical Goods and Apparatus.

To	Total electrical goods and apparatus.		Wires and cables. Rubber insulated. Not telegraph and telephone.		Wires and cables. Insulation other than rubber. Not telegraph and telephone.		Wires and cables insulated. Telegraph and telephone.		Wires and cables insulated. Submarine telegraph and telephone.		Telegraph and telephone apparatus.		Incandescent lamps.		Batteries.	
	1913. £	1920. £	1913. £	1920. £	1913. £	1920. £	1913. £	1920. £	1913. £	1920. £	1913. £	1920. £	1913. £	1920. £	1913. £	1920. £
All countries	5,386,000	11,601,000	422,000	1,753,000	541,000	2,041,000	711,000	1,040,000	1,904,000	1.777,000*	290,000	1,224,000†	152,000	320,000	226,000	628,000
Including to—																
India	361,000	2,478,000	64,000	451,000	66,000	274,000	27,000	379,000	—	194,000	33,000	220,000	28,000	80,000	43,000	255,000
Australia	781,000	1,128,000	132,000	345,000	133,000	237,000	251,000	108,000	—	—	47,000	30,000	40,000	72,000	27,000	43,000
New Zealand	158,000	433,000	23,000	165,000	14,000	41,000	66,000	15,000	—	—	4,500	9,000	8,000	20,000	—	23,000
South Africa	338,000	776,000	54,000	125,000	64,000	116,000	53,000	39,000	—	—	14,000	80,000	20,000	22,000	28,000	56,000
Egypt	69,000	273,000	3,000	10,000	—	—	—	—	37,000	130,000	6,000	51,000	—	7,000	3,500	11,000
Holland	34,000	872,000	9,000	156,000	7,000	344,000	—	160,000	—	—	—	57,000	—	—	1,000	15,500
Norway...	10,000	698,000	—	64,000	—	339,000	1,000	47,000	2,000	95,000	500	30,000	—	—	—	—
Spain	64,000	134,000	1,500	2,700	15,500	22,000	—	—	—	—	8,000	51,000	—	—	—	6,000
China	115,000	408,000	5,500	29,000	20,000	106,000	30,000	5,000	7,000	111,000	6,000	39,000	7,000	11,000	3,000	5,000
Japan	119,000	426,000	—	—	18,000	—	25,000	5,000	6,000	350,000	8,000	17,000	—	—	17,000	—
Argentine	386,000	485,000	62,000	68,000	84,000	44,000	87,000	69,000	—	—	33,000	102,000	14,000	7,500	24,000	44,000
Brazil	259,000	254,000	11,500	14,000	3,000	9,000	49,000	10,000	81,000	109 000	21,000	40,000	5,000	3,000	7,500	14,000
1921 totals	—	13,040,000	—	1,232,000	—	2,073,000	—	1,619,000	—	2,146,000	—	2,053,000	—	443,000	—	675,000

* U.S.A., £131,000. † Belgium, £67,000.

C.—Imports into Britain of Foreign Electrical Goods and Machinery.

—	Wires and cables. Rubber insulated.		Wires and cables. Insulation other than rubber.		Telegraph and telephone apparatus.		Carbons.		Incandescent lamps.		Sundry electrical apparatus.		Generators and turbo-generator sets.	Traction motors.	Other motors.	Sundry electrica machinery
	1913 £	1920 £	1913 £	1920 £	1913 £	1920 £	1913 £	1920 £	1913 £	1920 £	1913 £	1920 £	1920 £	1920 £	1920 £	1920 £
Total from all countries	379,000	33,000	75,000	134,000	252,000	243,000	163,000	153,000	196,000	75,000	254,000	581,000	159,000	165,000	263,000	729,000
Including from—																
Sweden...	—	—	—	—	79,000	21,000	—	—	—	—	500	31,000	1,500	—	93,000	3,000
Germany	262,000	3,000	64,000	1,000	39,000	11,000	97,000	6,500	—	3,000	112,000	36,000	—	—	7,000	10,000
Holland	—	—	—	3,000	—	—	500	—	16,000	45,000	—	—	—	—	8,500	16,000
Switzerland	12,000	—	—	—	—	1,000	1,500	2,500	—	4,000	4,000	65,000	1,270	14,000	16,000	24,000
Italy	52,000	8,000	4,500	16,000	—	—	—	—	—	—	—	—	—	—	4,000	7,000
United States	4,000	7,500	2,500	106,000	30,000	164,000	4,000	119,000	—	2,000	99,000	326,000	15,000	151,000	100,000	566,000
1921 totals	—	43,000	—	105,000	—	309,000	—	94,000	—	280,000	—	434,000	107,000	13,000	252,000	292,000

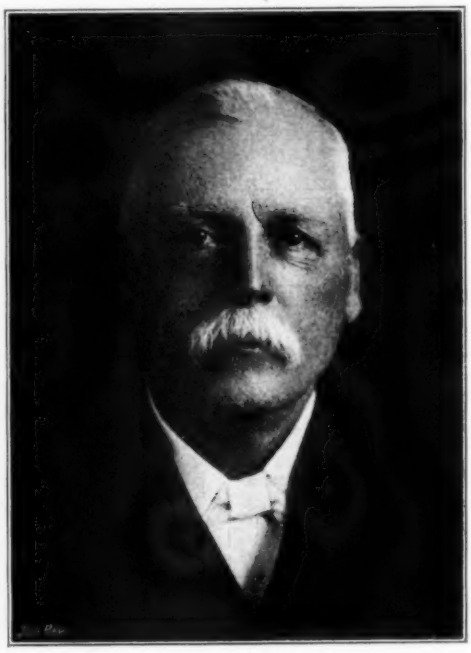
CABLE MANUFACTURE AND THE CHEAPENING OF ELECTRICITY.

By SIR GEORGE SUTTON, Bart.

It is always interesting to glance back over forty or fifty years and speculate on the changes time has wrought. To consider what has been done, what is being done, and what is waiting to be done, in the field of applied electricity is to make one conscious of the great possibilities of the future of the industry, and that marvellous as are the past records, the young men engaged in the industry to-day have a splendid field of research and accomplishment in front of them. Electrical science permeates every phase of life, and we, who are building in no matter how small a way on the foundations laid by Michael Faraday, have indeed stepped into a fascinating heritage.

An obviously important factor in the development of the electrical industry is the lowering of the cost of supply—not only at the station end, but at the consumers' point. Reducing station costs by improvements in thermal efficiency and operating expense is not sufficient. All efforts in this direction must be supplemented by the provision of cheap transmission. Since Ferranti produced the famous Deptford cable over thirty years ago and the impregnated paper cable of to-day came into use, improvements in cable manufacture have been constantly taking place, though no event has occurred in epoch-making as the introduction of paper for insulating.

One of the most important lines for development by the cable maker is the still further lowering of costs; but, of course, care has to be taken to discriminate between initial cost only, and initial cost plus subsequent maintenance. The second factor is sometimes overlooked when cables are purchased, but the desired progress of electrical activities will not follow as rapidly as it should, if the cheapening is carried beyond the limit consistent with quality. A 10 per cent. saving on prime cost, accompanied by a 50 per cent. reduction in life, is rarely good economics, and such practice, where followed, will result in the postponing of the electrical millennium as effectively as could any deliberate course of conduct.



City Studios] [*London.*

Sir George Sutton, Bart.,
Chairman and Managing Director of W. T. Henley's Telegraph Works Co., Ltd.

The possibilities of cheapening high-grade cables are, of course, receiving constant attention at the hands of the leading manufacturers, both by perfection of works organisation and by scientific research into the quality of raw materials and works processes. Cable-making can no longer remain a matter of empiricism, but must be based on sound scientific principles, and on the application of all known relative data in physics and chemistry. It is largely on account of the consideration of these factors that I am an optimist as to the future of electric cables, both as regards lowering of price and perfection of quality.

The development of power cables for higher and higher working voltages has, I suppose, been one of the most remarkable lines of progress and one which will contribute most largely to the cheapening of electricity supply. At the present time cables for 33,000 volts are quite common, and several makers are offering them for 66,000 volts. This advance is, of course, the result of a large amount of research work, and our ideas on some of the most important characteristics indicating the quality of a high-voltage cable have considerably changed during the past fifteen years. The importance, for instance, of such a question as dielectric power factor is now very widely appreciated, and the first-class cable works are equipped for furnishing guaranteed figures, whereas only a few years ago the matter received practically no consideration.

On the telephone side of cable-making such revolutionary progress is not taking place. The introduction of the dry-core cable about 25 years ago marked a distinct step forward. The previously-employed gutta-percha-covered conductors were replaced by the air-spaced paper-insulated type, and as the wire of the open line was carried into a cable, so was the surrounding air with its electrical advantages. Since that time, however, only minor improvements have been effected in manufacture, and the same type of cable is in general use to-day.

I emphasise my belief that a great day is dawning for the electrical industry. I believe that the future of the industry was never brighter than it is to-day, and it is a happy augury for the continued success of the Electrical Review that the celebration of its jubilee and entry into its second half-century should coincide with a period when the industry which it so ably serves is also moving on into an era so full of promise.

The Triumph of the Cable.—Fifty years ago, the only "cables" known to electrical engineering were those used for submarine telegraphy — the cores of which consisted of seven strands of No. 20 B.W.G. copper wire, enclosed in an insulating waterproof sheath of gutta-percha. To-day the submarine cable core consists of the same materials modified only in detail; and the excellence of the work of the British submarine cable manufacturers may be judged from the fact that some of those original cables are still in use.

Since then our cable makers have maintained their pre-eminence—but what immense progress has been made! Whereas those early telegraph cables carried currents measured in milliamperes, at a pressure of, say, fifty volts, we now have power cables four inches in external diameter, capable of carrying 15,000 kilowatts at 33,000 volts between phases. Moreover, the makers are prepared to supply cables for twice that pressure, as a commercial proposition. By no other means known to engineering could a power of 15,000 kW be transmitted through an aperture three inches in diameter—the external diameter of the lead sheath of a 33,000-volt cable

THE "ELECTRICAL REVIEW" AND THE INDUSTRY.

By B. LONGBOTTOM, Chairman of the B.E.A.M.A. Council.

In offering most hearty congratulations to the Electrical Review upon its fiftieth birthday, I feel that I must place on record my personal appreciation of its high standard as a paper and of the efficient manner in which it represents the interests of the electrical industry.

In doing so, two thoughts occur to me.

The first is the extreme youth of our industry, as British industries reckon age; for the births of the industry and the Review are almost synchronous.

The second is the immense service which it has been the good fortune of the Review to render to that industry during a period which is, by universal consent, the most trying and difficult of all—the period of youth and growth. Its consistent advocacy of progressive ideas; the uniform excellence of its articles; the model of good editing which it presents to us week by week—to all of these things we have become so accustomed that it needs an effort to realise that they might not have been so, and to remember how much they have meant to all who have lived during the past half century of extremely rapid progress and development.

Every member of the industry must have been influenced from time to time by its varied articles on organisation—not the necessary and proper organisation of a private concern, but the much larger problem of the organisation of an industry, to be brought about by conferences between the members of its various branches on the principle of common interest and reasoned discussion. I am not sure, but I think I am correct in saying that our earlier attempt at co-operation was, if not actually instigated, certainly inspired, by the Review—I mean the National Electrical Manufacturers' Association. I also recall with gratitude the help and encouragement which it gave to the B.E.A.M.A. in its early days. It clearly recognised the need of co-operation between the Press and the B.E.A.M.A. if the activities of the latter were to be fully understood and appreciated—and I gladly seize the present opportunity of saying on behalf of the B.E.A.M.A. how greatly we appreciate all that the Review has been to us. There is a saying that every country gets the Press it deserves. If the same thing applies to an industry, then this industry, as it appears to me, should be congratulated on having its Electrical Review.

Just as the electrical industry is bound to surge onwards, so must the Electrical Review forge ahead, ever voicing the needs and aspirations of the industry and providing the medium through which the world is reached, and I heartily and sincerely wish the Electrical Review "Long life and an increased circulation" so that its services to the electrical industry may be continued and increased.

Lafayette] *[Manchester.*

Mr. B. Longbottom,

Chairman of the British Electrical and Allied Manufacturers' Association.

The Chairman of the B.E.A.M.A. Council.

Our readers will recall that period in the history of the British electrical industry previously to 1911, when the "association" idea had at length taken root, and had resulted in the establishment of the Electrical Contractors' Association and of the National Electrical Manufacturers' Association, at the birth of both of which bodies this paper was able to render some little assistance. The growth of both associations was indicative of what might be done in a larger way, and amongst those who were the first to grasp that fact and to press the manufacturers' case for the wider outlook and a more vigorous policy of active co-operation was Mr. Benjamin Longbottom, who now presides over the Council of the B.E.A.M.A. Our pages bear testimony to the part we took in the transformation in 1911 of the old N.E.M.A. into the present Association, the B.E.A.M.A., the record of which, after ten years of work, can be safely left to speak for itself, or perhaps we might pay it the compliment of suggesting that it is now a little difficult to picture the exact state or recall the exact "atmosphere" of the electrical industry in pre-B.E.A.M.A. days.

Mr. Longbottom, whose communication we print above, is in his forty-seventh year, and has controlled the destinies of Electromotors, Ltd., Openshaw, Manchester, for over twenty-two years, from which it will be seen at what an early age he came into his responsibilities. Any manufacturer of electrical machinery in a large way could not but be interested in the particular section of the then growing B.E.A.M.A. which represented his branch of the industry, and, in fact (leaving aside Mr. Longbottom's connection with the Association as one of its founders), he soon took the office, which he still retains, of chairman of one of the most active of its Sections—the Dynamo and Motor Section.

From the chairmanship of an important section to the chairmanship of the Council itself, which represents every section, is not too difficult a transition for the right and willing man; and Mr. Longbottom was unanimously elected to that office during the present session. The position is by no means a sinecure; but Mr. Longbottom, with his gift for organisation, manages to give full time also to a variety of other public and private duties in connection with the F.B.I., the E.D.A., and the Negotiating Committee of the Engineering and the National Employers' Federations. He is vice-chairman of Richard Johnson, Clapham & Morris, Ltd., and a director of Lo-Thermo Patents, Ltd.

The war work of Electromotors, Ltd., was of an exceptionally strenuous character, and earned from the authorities special marks of recognition. In his personal capacity, Mr. Longbottom took an active part in the work of the Advisory Committee, Ministry of Munitions; the Electrical Trades (New Industries) Committee; the Ministry of Labour Trades Advisory Committee for Disabled Sailors and Soldiers; while he rendered a great variety of services on committees of the industrial or scientific bodies with which he is connected. He is, of course, a member of the two leading institutions, the "Electricals" and "Mechanicals."

REFLECTIONS, PAST AND PRESENT, OF A MANUFACTURER.

By HUGO HIRST.

On the occasion of your fiftieth anniversary, I am reminded that I have just concluded forty years' hard and continuous work in the service of the electrical industry. In these days probably only a small number of your readers remember the entrance of electricity into our social structure: it may not be out of place, therefore, to record some of my impressions in the early days of this mysterious, seductive, and inspiring force and its implements as I found them.

I speak of the early 'eighties, when England was still lit by bad gas, oil, and candles. An installation of a few arc lamps here and there or an electric light plant of 20 or 30 kilowatts, was one of the wonders and sights attracting visitors from all parts of the country and abroad. The telephone had only just become practical, and the idea of telephone exchanges seemed almost chimerical. An electric bell was considered a scientific instrument, costing guineas instead of pence. The names "accumulators," "transformers," and "resistances" were only known to those who were initiated into the innermost secrets of this mysterious force, and words like "volt," "ohms," "amperes," and "watts" were understood by a few scientists, but used quite frequently by would-be electrical engineers to impress an unsuspecting public with their wisdom. Yet those imperfect apparatus spoke of the coming of the Electric Age in no weak and inaudible voice. They made their appearance at a time when the world seemed full of adventurous spirits whose imagination was fired by the magic word "electricity," its possibilities and potentialities. I seem to have been one of them. We all thought we could change the world in a few years and make our fortunes. We believed this electric infant, as it was called, could grow into a strong being without the feeding bottle or without having to go through infantile diseases.

Elliott & Fry [*London.*

HUGO HIRST,
Chairman and Managing Director of the General Electric Co., Ltd.

I am amazed to-day, when I ponder over the future of the electrical industry, that the picture has not changed substantially from that which our imagination painted forty years ago.

I started with the Electrical Power Storage Co., where everybody in those days was convinced that accumulators would in due course be carried to people's houses, factories, and ships to supply them with their weekly or monthly light and power. The engineers of that company designed a 3-h.p. motor to propel a little boat on the Thames, and we were all convinced that within a few years ships, tramways, railways, and vehicles of every kind would be propelled by the electric current generated in central stations dotted all over the country for the purpose of charging the cells. Electric lamps consuming six watts per candle were calculated to be cheaper than gas-light, and we were all satisfied that it required only a few experiments to find some other material for the filament, in order that light should be produced cheaply enough to illuminate the country when the sun had gone down.

The heat generated by lamps and resistances brought up in our minds the possibility of heating and cooking by electricity, and even in those early days a number of people—including Sir William Siemens—were convinced that the rays emitted by the electric lamp had a beneficial effect on the growth of plants which, in due course, would lead to improving the fertility of the soil.

Your paper, better than any other, has reason to know the attempts of those who tried to exploit the electric current for healing purposes. As regards the telephone, nobody doubted that in due course everybody on this globe would be able to talk to anybody else wherever he might be.

What electricity really was did not seem to matter. They knew it was something that could not be seen, that could scarcely be measured, but nothing would dissuade us in our ideas as to what it might achieve, and accordingly we set to work with most ambitious schemes. The imperfection of the apparatus at our disposal led to temporary disillusion: failures were the rule rather than the exception. Few people to-day realise that cables and wires in those days were still clamped into terminals taken over from telegraph practice: switches were designed on wood, and it was the subject of a patent to have a spring contact or direct a current through the switch without its passing through the moving parts. Switchboards were a mere collection of switches grouped in an orderly manner. Wires in houses hung loose like garlands, connected to wooden lampholders with exposed terminals. Cut-outs were merely terminals in which was inserted a piece of lead wire. Dynamos and motors were merely revolving electromagnets which were expected sooner or later to burn out through overheating.

In the light of to-day's knowledge, it is not to be wondered at that so many breakdowns happened—the wonder is that anything ever worked!

Some were undaunted by these failures and proceeded with grandiose schemes which led to a financial disaster in the electrical industry and consequent legislation which, for some time, stopped all progress. Others realised—and I belonged to them—that before electricity could play its revolutionary part in the life of mankind, all the parts belonging to an electric power or light installation would have to be studied and technically worked out, and that not until fireproof and foolproof apparatus and accessories forming part of an installation could be designed after proper study of their functions, could the real progress of the electrical industry set in.

To take its full share in the development of electrical apparatus was the task which the General Electric Co. set itself from the early beginning. Its early advertisements in your Journal, together with its earliest 16-page catalogue beginning with a bell-push and showing on the last page a complete electric tramcar, are proof that the fascinating possibilities were ever present in my

mind in the early days of our humble beginning. The certainty that electricity would some day dominate all problems of light, power, and heat has always encouraged me to risk all gain in new developments. All my actions, all my utterances by pen or by word of mouth, have breathed enthusiasm and confidence that the electric current will some day dominate or influence all activities of a higher civilisation, and I am of the same opinion still. A temporary disarrangement of the mentality of the industrial world, resulting in the present industrial depression, cannot damp my belief in our future.

The forty years which have passed seem only forty days which have been spent assiduously in forging our tools to commence the real task which we set ourselves then. Forty years' experience has given us a clearer vision of what is required and how we should go to work.

The field in front of us is as great as ever. Coal is still used in the primitive manner as before. Water power in the Empire has scarcely been touched. The difference between the present electric light stations and power stations in the country and those that I visualise eventually, is not less than the difference between the 100-kilowatt sets of the early 'eighties and the 20,000-kilowatt set of modern days. The country will not rest until we can tap the current in any part for light, heat, and power in homes and factories, or for transport, and for agriculture. Cheap transport is the greatest necessity for an industrial nation, and only electricity can give it to us. Railway electrification and propulsion of ships have become a reality. Superstations cannot be delayed much longer. A cheap unit is, in my opinion—as I recently expressed it—the most essential raw material for this country. When I picture the numerous activities that electric current can perform in our homes, in our factories, in our mines, on the land, when I give a thought to electro-metallurgy, electro-chemistry, and to medical electricity, I stand aghast at the number of appliances which can be conceived and will have to be produced in thousands and hundred thousands to satisfy the demands of the public.

When I compare the present state of telephony in this and any other country and its possibilities, when I realise the need that everything may have to be scrapped in the course of a generation in order to give such service as, in the light of to-day's knowledge, it is possible to give, I see a field of unlimited activities. When I realise the progress of wireless in recent years through the coming of the electric valve, its influence on communication throughout the world, its possible application even in the sphere of light and power, I feel jealous of those who come after me and who can take part in that development. I am satisfied that factories existing in this country will be none too big for the demand that will be established if agitators in labour and politics will temporarily withdraw from the stage and let the people of this country work out their own salvation.

That belief and spirit has guided me through my long career and served me for the purpose of inspiring others. It has been the mainspring of everything I have undertaken and risked, and I do not think I shall ever change my views.

ELECTRICAL AFFAIRS IN INDIA.

(From a Special Correspondent in India.)

Greetings and hearty congratulations from the electrical fraternity in India on the attainment of the fiftieth year of publication of the Electrical Review! It is difficult to realise a fifty-year-old electrical weekly, as there are still those unsophisticated people who talk of "electricity being in its infancy," and therefore, by implication, a paper entirely devoted to its interests must be in its juvenile stages. However this may be, the Review has attained a good ripe age as things go, and for a healthy spell of fifty years has played its part, which was no small part, in the wonderful developments which have taken place in the advancement and practical applications of the science of electricity. Most publications have their material as well as their moral existence—the Review as well as the rest of us has to live and pay its way. The moral side of the Electrical Review, or rather its policy with regard to the development generally of the industry, has always been for good, and has had wisdom and experience for its guide. On technical questions, where differences of expert opinion will always arise—and it is healthy that they should arise—the Review has always fairly and impartially listened to both sides and thrown its columns open to all comers who have anything relevant to say. In labour disputes it has also been equally fair, and, if anything, has championed the cause of the weak against the strong. This all points to the fact that the moral side or character of the paper is right, and proves, further, that it is what a paper of its kind should be, strictly fair, honest, courageous, and with a sense of justice to its readers; influencing the policy of the whole electrical manufacturing community, stimulating, assisting, and educating it towards better methods and ends.

From the material standpoint, the Review is, judging from the number of its readers and the quantity and style of its advertisement sheets, in a strong position. In India it is looked forward to each mail with keen, live interest; it is seen in nearly all station clubs and reading rooms, and it is to be found on the office tables in all important mercantile and importing houses, both Indian and European. Its advertisement pages are eagerly scanned for new matter, for fresh and interesting articles of electrical commerce which may appear marketable here; and one could hazard the opinion that the Review could boast, if it were not so modest, of being the means of bringing as many or more new customers from India to England as any other medium printed.

Having been a fairly constant reader for upwards of half its lifetime, one is tempted to become reminiscent and go back in memory over the old days and early struggles; but the temptation must be resisted. Perhaps a few hints to those of your manufacturing and other readers who may be interested in Indian possibilities of electrical business would be useful. India is a country of wonderful mechanical and electrical possibilities. Due to many contributory causes, a new era of Industrial Commission sat from 1916 to 1918 and issued a report subsequently, which went into detail as to the resources and water-power capabilities of the country, also multifarious other important matters bearing on industrial development were dealt with in detail. This was soon followed by a hydro-electric survey and report by technical experts, and by a report of the Store Purchases Committee. A most valuable publication recently issued is a "General Review of the Conditions and Prospects of British Trade in India," by H.M. Senior Trade Commissioner. All these reports are chock-full of useful and reliable information for those who wish to use it to the advantage of the country and incidentally of themselves, and should be procured and studied carefully. A warning note has been struck by the Senior Trade Commissioner in India in his Report of 1920-21. It is as follows:—

"A most important factor to be considered is the risk that if British manufacturers do not take advantage of such industrial opportunities as India presents, our foreign competitors may do so, and thereby undersell our imported goods in the market. The Japanese have recently made several endeavours to secure a footing in Indian industries, but so far without much success, while one or two American manufacturing firms are merely awaiting their opportunity."

AFTER FIFTY YEARS.

Development of Electrical Engineering in the Far East.

By C. A. MIDDLETON SMITH, M.Sc., &c. (Taikoo Professor of Engineering and Director of the Engineering Laboratories and Workshops in the University of Hongkong).

A Letter—and Recollections. The boom of a gun wakened many of us in this colony to-day. The sound brought to us good news, for we knew that the English mail had arrived. Some of us, feeling energetic, despite the hot and humid night which is to be experienced only in the tropics, went out on to the verandah in order to see the P. & O. *Macedonia* steam up the harbour. It was her first voyage to Hongkong, and we were curious to see the ship in which we hoped at some time to travel home to England. Practically every European house in the Colony overlooks the splendid harbour, and each has its wide verandah. There is something remarkably cheering in watching the carrier of the English mail thread her way amidst the Chinese junks, sampans, and the merchant ships of many nations, as well as the cruisers and destroyers which fly the white ensign. In the wonderful harbour of Hongkong they lie side by side, these junks of the Far East and the merchant vessels of the West. They are symbols of what has been and what is to be. They remind us that modern mechanism is replacing, even in this part of the world, the elementary ideas of past centuries concerning the utilisation of Nature's vast resources.

We guessed concerning the senders of letters from home, and, as usual, an unexpected letter arrived. It contained an invitation to contribute to the Jubilee Number of the Electrical Review. That letter brought a flush of pleasure to the writer's mind, for it is now twenty-one years ago that he, a young engineer in Birmingham, pushed into a pillar-box his first contribution to a technical journal. It had been inspired by an article in this Journal, and it was addressed to the Editor. The would-be contributor thought it inevitable that his work had been wasted. Would the mysterious Gods of Olympus in the editorial chairs on Ludgate Hill be other than irritated by such insolence as a criticism of what had appeared in the pages which they, and their army of assistants, produced as weekly evidence of their exalted knowledge?

Wonder of wonders—the Gods not only took notice, but replied in most encouraging terms per return of post. They were still mysterious—they signed themselves "The Editors." But there was something so human, so charming, in that encouraging reply that the young man struggling in the whirlpool of factory life in the Midlands determined to seek them out. And that is how he met, and made a friendship with that great-hearted Briton, T. E. Gatehouse. It is unfortunately true that Gatehouse has gone over to the "great majority," but in one sense this Jubilee issue is a memorial of his work. Of his colleagues still in harness it is impossible to speak in personal terms, but a tribute must be paid to that splendid man who inspired at least one young engineer to believe that his was indeed a noble profession and second to none in giving benefactions to humanity. That is why for all the ten long years of exile, and for all the ten thousand miles that separates this pen from the printing presses, it is a privilege to send to the Electrical Review a wish for a long and prosperous career. This journal has always been useful; indeed it must, from the very nature of its mission, always be useful. May it always remain true to its magnificent traditions of the past, and while retaining its older friendships, inspire the young men of the engineering profession with the ambition to spend themselves to the uttermost in the profession which has in the past fifty years showered so many benefits on poor struggling humanity.

The Engineer Adventurers.—Three or four hundred years ago the foundations of Empire were being laid by those wonderful merchant adventurers who carried the British flag to all parts of the world. In this century the foundations of a new world are being laid in every land by Anglo-Saxon engineers, who are demonstrating that only by utilising the forces of Nature can there be any real improvement in the conditions of life on this planet. This is the era of the engineer-adventurer whose energy is spent in attempting to make life easier and happier for others. In the designing office, in the laboratory, or far away from his own country in the planning, erection, or running of machinery, he is building up the new and better world. Yet, in order to fully understand the real significance of his efforts, you must travel. If a paraphrase will be excused, it may be asked, "What do they know of British inventions and machinery who only British workshops know?" You must see the wonderful transformation all over the world, but especially in the tropics, that has followed the work of Watt, Faraday, Wheatstone, and the other immortals, in order to understand.

The problem of to-day is so simple that engineers may almost be excused for the impatience with which they regard the human forces of inertia, such as ignorance, pride, and selfishness, which retard them in their work and which prevent a rapid solution to the problem. The forces of Nature are available; the workshops of Britain are equipped for the building of machinery to make use of them. In the Far East there is enormous natural wealth. Machinery, and yet again machinery, is needed to unlock the gifts of Nature and to transport the natural treasures so that they may be used to the fullest advantage. In China especially, even in these enlightened days, the intrigues of the official parasites who toil not, but who batten on the spoils of office, block the path of the engineer, just as did our own more honest, but equally stupid, legislators with their absurd "Red Flag" Acts and the insane edicts which strangled early electrical developments. Fortunately we are sure of ultimate success. We may not accomplish all that we so ardently desire to do in our own short working life, but we know that always we are making progress. And as we see what has been accomplished by engineering science, and especially by the electrical branch of the science during the past fifty years, we may indeed envy those future generations for whom we are working.

The Wonderful East.—It is, particularly to the amazing transformation in the Far East that is happening in this generation, that attention should be directed. For just as the last century witnessed the passing of Europe from old ideas of production into the use of machinery, so shall we see, in this century, China replacing muscular energy by electrical power.

It is difficult for the modern engineer to conjure up a vision of the Far East for the year 1872. It is probable that the only evidence of nineteenth-century applied science to be seen out here in those days were a few steamships and the beginnings of the equipment for small local shipyards. Remember that Japan was, at that date, unaffected by Western science. Of the pioneers who went out to Nippon to teach those who delight to hear their country called "The Britain of the Far East," Sir Alfred Ewing is still an active pioneer of applied science in Scotland, and many readers of this journal remember the personalities of Ayrton and Perry.

Fifty years ago there was not a railway east of India; the steamships were small and uncomfortable, and they must have been very much outnumbered by the sailing ships; there are men out here who have taken five months on the journey from Britain to the Far East.

THE FUTURE OF ELECTRICITY IN CANADA.—I.

By P. T. DAVIES, A.M.I.E.E., President, Canadian Electrical Association.

Canada is already well developed electrically. There are to-day very few industrial companies using any other form of motive power than electricity obtained from hydro-electric generating stations. The domestic use of electricity is rapidly approaching 100 per cent. where electric lines are available, and even the rural districts are now being reached by farm lines, which in some cases are constructed with provincial aid.

Development in the future will therefore depend more upon the growth of Canada as a manufacturing country, the general increase of population, and financially upon new uses of electricity.

The growth of Canada as an industrial country is proceeding apace, each year finding larger numbers of new factories to manufacture those things which previously have been imported. The increase in branches of American firms is steady and proceeding at a greater rate each year. There are over 800 branches of American manufacturing organisations in Canada to-day, most of which have been established within the last five years. These factories are planning for expansion to supply not only the needs of Canada, but also the needs of those countries that have a preferential tariff on goods imported from Canada. This embraces most of the countries forming the British Empire.

Mr. P. T. Davies,
President, Canadian Electrical Association.

It has been a matter of considerable disappointment that English companies have not found it possible to establish branches in Canada, excepting in very rare instances. This question has consistently been put before English manufacturers, Boards of Trade, and other interested parties, in the most thorough manner possible by Canadian power companies and provincial and Federal Government agencies, yet the results are meagre, and the steady infiltration of American plants seems to point to the Americanisation of Canadian industrial life.

The growth of the population, being dependent upon immigration, is problematical. Canada to-day is pursuing the policy of selected immigration, which will necessarily mean the slowing up of progress.

New uses of electricity offer the most attractive field for electrical expansion. The record of one large power company, in connecting up some 40,000 kW of electrical steam generating boilers to use surplus power, is a notable step. Such installations are, of course, only possible when situated near the source of power and where surplus capacity is frequently available.

When it is considered that only some 10 per cent. of the readily available water power in Canada has been developed, and transmission distances of some 500 to 1,000 miles are now economically and commercially possible, and further, that a market for several million horse power is present south of the border line between Canada and the United States, within transmission distance of such water powers, one of the problems which Canada will have to decide in the near future will be whether large quantities of power will be exported, or whether the best interests of Canada will be served by retaining it for home use.

Electrification of railroads has progressed very slowly, but in the near future electrification of the terminals of our large cities will undoubtedly be carried out. This will call for a relatively large amount of equipment, both electrical and mechanical.

With the diminution of wood products, and lack of Canadian household fuel, electric cooking will tend to become more and more general. The growth of electric cooking at the present time is accumulative; each new installation brings others in its train. It is fairly safe to predict, where natural or artificial gas is not available, that within the next five years the revenue from electric cooking and water heating will exceed that from electric lighting.

The record of most Canadian central stations is that the load doubles every five years. I see no reason to anticipate any reduction in this rate of growth.

The sudden expansion of temporary loads during the war period has now been completely discounted, and all central stations to-day in Canada find their load increasing more rapidly than the normal rate of past years; as a result, there will be a steady demand for increased power facilities and equipment, making the business more profitable for manufacturers in the near future.

One large English electrical manufacturing company has formed affiliations with a Canadian organisation, and is now quoting on, and supplying large contracts with, apparatus manufactured in Canada.

II.—BY OUR SPECIAL CORRESPONDENT.

To forecast the future of anything in this world, unless one is possessed of prophetic powers, resolves itself into a matter of estimating the probable effect of certain factors already in existence or likely to come into being before or during the period covered by the forecast.

Assuming, then, that Canada will be free from serious disturbances due to war, industrial upheavals, and the like, it may be safely predicted that this country's electrical future is of the brightest since here exist all the elements essential to great development.

Canada, considering her vast size and her small population, stands in the very forefront in electrical progress, for which she is indebted to her wonderful heritage in natural resources, combined with the enterprise of her engineers and the greater readiness of the people at large to take up new things as compared with the inhabitants of older countries.

In telegraph and telephone engineering, great distances, absence of good roads, and sparse population have combined to provide this country with over 50,000 miles of telegraph lines, while the wire mileage for telephones is now well over 2,000,000 miles, serving more than three-quarters of a million telephones, or a telephone for one person in every ten approximately. In heavy-current electrical engineering, Canada's achievements have been specially notable, due in no small degree to the fact that two of her largest provinces—Ontario and Quebec—which are also the most thickly populated, possess practically no coal, but are compensated for this by having some of the finest water-power sites in the world.

In Canada to-day are several hundreds of miles of 110,000-volt transmission lines and some thousands of miles of lines at lower potentials—66,000, 44,000, 22,000, 13,200, and other voltages down to the ordinary distribution voltages of 2,200, 550, 220, and 110 volts. The territory covered must be several times the area of England, and the various weather conditions which these lines have to withstand, and do to a very large extent successfully withstand, comprising temperatures ranging from over 100 deg. F. to 20 deg. or 40 deg. F. below zero, heavy ice loads, and violent thunderstorms, are such as probably no other lines at present in existence elsewhere in the British Empire have to cope with.

Canada possesses several hydraulic turbines and generators of a greater capacity than any others ever built, and larger ones still up to 100,000 h.p. in a single unit are in contemplation for the near future. She has the greatest single hydro-electric development in the world, where three of the generators (55,000 h.p. each), mentioned above, are in actual operation, two more will be operating within the next few months, and the complete development (Queenston-Chippawa) will have nine immense units, some of which will be of 75,000 h.p. each. The foregoing relates to Ontario, where already plans for another Queenston-Chippawa canal as large as, or possibly larger than, the present one, are being considered. In Quebec the developments now run into several hundreds of thousands of h.p., and big extensions will be necessary within the next few years if progress is not to be halted.

Manitoba, Alberta, and British Columbia all have developments of no small size, and are either carrying out, or contemplating, large increases. Nova Scotia and New Brunswick also are actively developing their water powers, though their work is not so spectacular as that in some of the other provinces, because the water powers are of much smaller size. In Saskatchewan coal and oil are used chiefly as prime sources of energy, and no large plants are as yet in use there.

It is noteworthy that in Ontario the average individual domestic load has just about doubled in the past five years owing to the extensive use that is being made of electric ranges and water heaters, as well as the more common devices, such as toasters, coffee percolators, vacuum cleaners, and the like. Rural power is also slowly creating a load that will one day be of considerable magnitude.

It would be a simple matter to enlarge upon the advantages of low-priced electric energy for industrial, commercial, and domestic use, and to show in detail how extremely rapid has been the growth of loads in the more favoured and more settled parts of the country, but this would take up too much space. Such uses of electric power already provide loads of great magnitude, but some day another outlet will be found when it becomes feasible to electrify the railways.

Electrification will add greatly to Canada's prosperity —in Ontario and Quebec it will save the importation of huge quantities of coal, in other provinces possessing coal it will save their coal for other uses; it will enable rolling stock now carrying coal to carry other merchandise; it will improve Canada's rate of exchange on her currency; it will enable trains to be run on better and faster time schedules; it will help appreciably to extend the life of the coal resources of the continent; and it will also tend to conserve the timber resources of the Dominion, as many forest fires have been traced in the past to sparks from coal-burning locomotives.

In no country in the world are the prospects for electrical development more favourable than in Canada. In no field of electrical activity has the saturation point been approached, so far as the use of electric energy is concerned, so that in this direction alone there is room for considerable expansion, but Canada can support a population of many times the number she now has, and the increase of her requirements for electrical products will, on account of growth of population, be very considerable for several decades to come.

Electrical manufacturers at home must not, however, imagine that because Canada's electrical needs are going to be very large for a considerable length of time that all they need to do is to send their products over here in order to do a profitable business. It is true that if the American Government persists in its present policy of keeping up a high tariff between this country and its own, such procedure will help the firms in Great Britain more than a little, and in some lines it may be possible to manufacture in England and find a market here; nevertheless, it cannot be too strongly emphasised that in other lines, particularly in connection with large transformers and other equipment intended for use at very high voltages, say, from 100 to 250 kilovolts, it would, in the opinion of the writer, be infinitely better to manufacture in Canada where the staff employed could be in direct touch with requirements and gain experience at first hand of actual working conditions.

Firms at home must consider Canada very seriously as a country in which they could gain most valuable experience of long-distance high-pressure transmission work and of hydro-electric development on a large scale; they should remember that such experience, owing to Canada's varied climate, would get them to meet the problems arising in almost any other quarter of the world; Canada, too, is comparatively near to Great Britain, yet forms a good stepping stone to the Far East, where one day there will be great developments. Practical experience gained in this country in work of the kind just specified would fit any firm to tackle the difficulties that might be expected in India, South Africa, China, or elsewhere far better than any experience gained in England.

It will cost money to establish works over here, and orders will certainly not pour in immediately, but once a foothold is gained, through perseverance and good work, there ought, for any firm that can stand the initial expense, to be good rewards in the shape of orders not only in Canada, but in other parts of the Empire, and even in foreign countries.

Though the foregoing remarks refer specially to electrical engineering projects of large size, yet the ordinary demand for motors, transformers, and auxiliary equipment, as well as for domestic current-consuming devices, will, of course, be very considerable.

The actual rate of growth of Canada's markets in these lines will, of course, be, to a large extent, dependent upon the rate of growth of the population. The conditions are such, however, at the present time that the writer believes that if home firms are to make a start here at all with any chance of success it should be within the next five years, otherwise, they will find themselves completely ousted by U.S.A. firms, many of which are establishing branch factories here, this policy being accelerated just now by the high-tariff policy of that country. This policy will not, however, obviate the need for British firms to manufacture here if they are to make real headway.

The "home country" is carrying heavy burdens, and new ventures in other lands are always problematical in results, but it is believed that Canada, as a field for British electrical manufacturers, is worthy of a good deal of careful study along the lines indicated above.

HYDRO-ELECTRIC DEVELOPMENT IN CANADA.

By Sir ADAM BECK, Kt., LL.D. (Chairman of the Hydro-Electric Power Commission of Ontario).

In connection with the request of the Electrical Review for a contribution to its special issue celebrating the completion of fifty years of continuous publication, I would state, first of all, that an *electrical* journal that has seen *fifty years* of service in the sphere of electrical activity deserves to be especially complimented, and it affords me much pleasure to express the hope that the Electrical Review will find that its fiftieth anniversary is but the entrance to future years of great public service and prosperity.

In your communication I note that you specially inquire whether some statement can be made which will justify hopefulness for the electrical industry in the Dominion of Canada as a part of the British Empire.

So far as hydro-electrical undertakings are concerned, I believe that in no part of the British Empire does the future hold greater promise by way of development than it does in the Dominion of Canada. Once hydro-electrical energy at reasonable rates becomes available, industries are inevitably attracted to the areas where the power is to be found, and a demand for still more power and further developments results.

Marked Development in all Canadian Provinces.—Canada is bountifully endowed with water powers, and it is important to bear in mind that over 90 per cent. of the total power generated in central stations in Canada is from water power.

In the Atlantic seaboard provinces of Nova Scotia and New Brunswick, public authorities, as well as private interests, have been taking action, and of late have greatly increased the output of hydro-electrical energy for the use of municipalities, as well as of industries, in these provinces.

In the province of Quebec the provincial authorities have given encouragement to the development of water power, including storage facilities, with the result that there has been a remarkable growth of manufacturing centres, such as at Chicoutimi, Drummondville, Grand Mère, Shawinigan, Sherbrooke, Three Rivers, and other places. Development work is still in progress.

In the province of Manitoba, the city of Winnipeg and other municipalities are increasing hydro-electric development on the Winnipeg River, which has an estimated potentiality of 450,000 h.p. The developments upon this river have already made the city of Winnipeg an important Western manufacturing centre. In the other prairie provinces of Saskatchewan and Alberta, owing to the flat character of the country, the water-power possibilities, relatively speaking, are naturally small, although some good powers are available in the undeveloped northern districts. There are no water-power developments of importance in the province of Saskatchewan, but in the foothill region of the Rocky Mountains in Western Alberta good use has been made of some of the available water powers, and effort is being put forth to increase their output.

In the province of British Columbia the water rights have been jealously guarded, and this province has demanded that these rights, when transferred to others, be *beneficially* used, otherwise they revert to the Crown. Both public authorities and private interests in British Columbia are seeking to make a greater development of electrical energy for service in connection with the commercialisation of the natural resources in this province.

It is, however, with hydro-electrical development in the province of Ontario that I am really familiar. The province of Ontario is exceptionally well endowed with water power, and both the Government and the people of this province are well alive to the economic value of this resource. Ontario, like her sister province, Quebec, has many large manufacturing centres, and numerous great water powers have been developed for use in pulp and paper, electro-chemical, and other manufacturing industries. On all hands, therefore, there is found a marked tendency to increase hydro-electrical development in order—as one chief incentive— to bring the natural resources of the country into greater service. The Hydro-Electric Power Commission of Ontario, in this connection, has recently completed the installation of the first units, aggregating 25,000 h.p., of a 75,000-h.p. plant on the Nipigon River for the development of the communities and natural resources of the Thunder Bay district, which is situated on Lake Superior at the head of the navigation of the Great Lakes. In its large new hydro-electric development on the Niagara River, in what is known as the Queenston - Chippawa plant, the Commission has provided for the ultimate development of 600,000 h.p., of which it is expected that 250,000 h.p. will be in use by the end of 1923.

Sir Adam Beck, Kt., LL.D.,
Chairman, Hydro-Electric Power Commission of Ontario.

Municipal Movement for Low-Cost Electricity.—In the province of Ontario there has been a special movement to make available for the citizens at large electrical energy "at cost," and the chief agency by means of which electrical energy at the prevailing low rates has actually been made available is the organisation known as the Hydro-Electric Power Commission of Ontario. This Commission was constituted to give expression to the desire of a number of municipalities in south-western Ontario to adopt a scheme of co-operative municipal ownership whereby electrical energy would be distributed under the control and guidance of an independent Commission freed from political interference.

Begun on a comparatively small scale, the work of the Commission—despite varied and at times strong opposition—has grown, until to-day it supplies electric light

and power to 50 per cent. of the population of the province of Ontario. This result has been accomplished in less than fifteen years.

Electricity, once a luxury, is now a common commodity of the people, as is attested by the magnitude and rate of growth of the domestic, commercial, and power loads on the Commission's systems, which indicate very clearly that the effort of the municipalities to provide hydro-electrical energy "at cost" has rendered its use popular for a great variety of purposes.

In order to distribute electrical energy at cost to the people of the province of Ontario, more than 300 municipalities acting co-operatively have invested over $200,000,000 in the hydro enterprise.

One of the most hopeful aspects of the outlook for the future of electrical industries is the extent of growth which has prevailed throughout the past, and of which present conditions give corresponding, if not indeed greater, promise for the future.

Remarkable Growth in Consumption and Development of Electrical Energy.—The extensive growth of electrical undertakings in the province of Ontario is well illustrated by the actual growth of the whole "hydro" undertaking. After initiating its undertaking in October, 1910, when the Commission was supplying only about 750 h.p., the service rendered by the Commission grew with great rapidity. At the end of five years, that is, in 1915, very nearly 104,000 h.p. was supplied to over 120,000 customers in 112 urban municipalities and 18 townships; and in 1921 over 305,000 h.p. was supplied to about 265,000 customers in 234 urban municipalities and 44 townships; and, in addition, about 70,000 h.p. was exported to the United States. At the present time the Commission is distributing a total of about 450,000 h.p., and operates over twenty water-power undertakings, which, when fully developed, will have a potentiality of over 1,000,000 h.p.

Hydro-Electric Power Commission of Ontario: Queenston-Chippawa Development.

Portion of completed power canal traversing the Niagara peninsula, as seen from the air, showing approach to Whirlpool Gully, and continuation to Forebay on the top of the cliff at the Niagara River, seen in the upper part of the picture.

The rates for light and power throughout the "hydro" system in Ontario are cheaper than for like service elsewhere in the world. It is actually hydro-electrical energy "at cost." Considering the operations of the Commission as a whole, it may be stated that the average cost of electrical energy to the consumer is, for domestic purposes, less than two and one-half cents per kilowatt-hour; for commercial purposes, less than two and three-quarter cents per kilowatt-hour; and for power used in industrial purposes, is less than $20.50 (£4 8s. 7d. at normal exchange) per h.p.-year. During the period within which the Commission has been operating, citizens of more than 300 municipalities now enjoying their "hydro" service have, for lighting alone, saved, through reduction of rates, about $60,000,000 over what would have been the cost under rates prevailing before their undertaking was initiated. Each year there is, where necessary, an adjustment made of the various rates charged in each of the co-operating municipalities, and by this means the various rates are kept in correspondence with the actual cost of the operations involved.

Past and Present Conditions Promise Great Future.—Power is not only a prime factor in world industry and commerce, but the extent of its use is also an indicator of the manner in which general industry and commerce are developing.

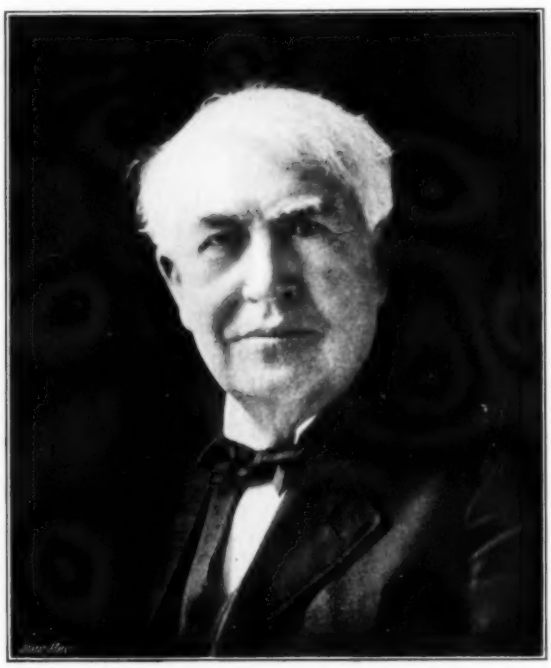
The central portion of Canada is indebted for its great industrial expansion of recent years to its water powers. These powers have been developed so as to produce the abundant and cheap supplies of hydro-electrical energy now being transmitted over an extensive network of lines to furnish electric light and power to homes and industries far removed from the sources of power supply. The length of the high-pressure lines alone of the Commission's great networks already aggregates over 3,000 miles.

The aim of the Hydro-Electric Power Commission has been to make electrical energy available at such low rates that rich and poor alike may share in its many advantages, and it is well within the fact to state that nowhere else in the world do so many of the general public make such extensive use of electricity in their homes as in the province of Ontario.

In conducting its work, the officers of the Commission naturally are brought into close touch with all phases of the electrical and allied industries. Although it is true that the electrical industries have, along with other general industries, suffered through conditions consequent upon the Great War, nevertheless, it is my judgment that in the recovery from business depression, the electrical industry will be one of the first to return to normal prosperity.

The electrical industry is basic to many other forms of industry and, consequently, in answer to your specific inquiry whether this portion of the British Empire can report hopefully with respect to the future of the electrical industry, I feel justified in stating that the substance of the things hoped for in this respect is already becoming manifest in practically every line of electrical activity and chiefly in the very source of such activity, namely, the development of electrical energy for municipal, domestic, and industrial purposes. Obviously, this implies that, in turn, the allied industries, including the manufacture of machine tools, electrical machinery, commercial, domestic, and other electrical apparatus, and the metal, rubber, glass, and other trades will all be called upon to supply their respective quotas to meet the demands which inevitably are created by new and extended applications of electricity. Let us, then, take courage and not be fearful to make preparation for the return to better business conditions of which the electrical industry already gives such substantial promise.

MESSAGES FROM EMINENT AMERICANS.



Mr. T. Alva Edison, who was recently presented by the Mayor of New York City with a key of the City in recognition of what he had done for New York since central-station service was started there 40 years ago.

Cable Address: "Edison, New York."

From the Laboratory
of
Thomas A. Edison,
Orange. N.J.

September 5th, 1922.

The Electrical Review,
4, Ludgate Hill,
London, E.C.4,
England.

Gentlemen:

The years have passed so swiftly that it is difficult for me to realise that half-a-century has slipped by since your excellent publication came into existence. Yet I understand that in November next you will celebrate the completion of fifty years' continuous publication of the Electrical Review. This is a notable event in the history of a publication devoted to electrical development, for a backward glance of fifty years in the art is somewhat akin to looking back to years of antiquity.

I think you are entitled to a pardonable pride in reviewing the growth of the Electrical Review and the many years of great and useful service it has given to the electrical profession. So, allow me to extend my hearty congratulations on the approaching commemoration of your Jubilee, and also my best wishes for an ever-increasing sphere of usefulness in the field you have so ably occupied.

Yours very truly,

Thos A Edison

Mr. Frank W. Smith, President of the National Electric Light Association, New York, whose article on "Electricity Supply in the United States" appears in this issue, writes:—

"On the occasion of the fiftieth anniversary of the founding of the Electrical Review, the National Electric Light Association extends congratulations and best wishes. This Association, of which the writer has the honour to be president, cannot boast of such longevity. It was organised in 1885, a few years after the starting of the electric light and power business in the United States, and is to-day the largest and most influential association of its kind in the world.

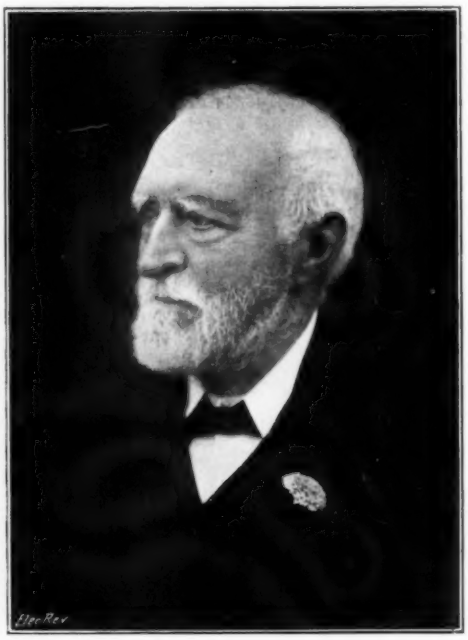
Enjoying as we do the common heritage of Anglo-Saxon civilisation and culture, we are naturally most interested in the development of the art among the English-speaking peoples. And how deeply are we indebted to Britain for what we enjoy to-day! We have indeed reason to remember England. We know what she has contributed to electric science and art. We do not forget Faraday or Maxwell, or Kelvin or Heaviside. We do not forget her other great engineers and savants like Hopkinson, Thompson, Parsons, Kapp, Ferranti, Swan, Merz, Wright, and a host of others living and dead who have added so much to the glory of our industry."

Frank W Smith

Mr. Frank W. Smith, Vice-President and General Manager, The United Electric Light and Power Co.; President, National Electric Light Association, New York, U.S.A.

A GLANCE BACKWARD.

The preparation of this issue of the Electrical Review has naturally brought about us in these editorial rooms a host of presences from the past. Try all we may to adopt the looking forward attitude, old and well-known forms persistently gather round us; familiar faces rise under imagination's influence, and voices silenced in the human sense seem to be heard again. It must be so in any walk of life where one has long witnessed the achievements of men as they have passed through their years of activity, their rise from comparative obscurity to eminence, and their subsequent gradual slowing down and sometimes passing into obscurity where their presence has been forgotten by some, and practically unknown to the newer men in the field of battle, indeed where their existence has been seldom remembered save by a few of their attached and faithful contemporaries. It is only ordinary kindness at such a time as this to send a word of greeting to the Old Friends who, though they may have disappeared from the public eye of the electrical profession and industry, are still keenly interested in the progress of electrical affairs. Let the present issue of the Review come to them as one more hearty handshake, just like the old ones, but even a little warmer and more affectionate—for are not the old friendships treasured more and more as the years pass along? Among the oldest—indeed we think *the* oldest—of our friends connected with electrical affairs we have to name Mr. George Offor, of Sydenham, who was born in March, 1827, and is well on toward his 96th birthday. He sends hearty congratulations upon the Fiftieth Birthday of the Electrical Review, "which has been of such service in promoting the industry," and we are sure that we are voicing the sentiments of those who remember his kindly and genial personality when we wish him continued health so that he may in a few years' time be congratulated upon the completion of his centenary. Mr. Offor is, we are glad to say, in excellent health, though he is not able to wander far from home. For the interest of our younger readers, we may say that Mr. Offor was one of the pioneers of electric supply work in this country. In his early work he was closely associated with the Brush Co., and later he had the assistance of Mr. Frank King as engineer of the company which he formed under the title of The Consolidated Electric Company, with works in Cowcross Street, London, E.C., where accumulators and numerous electrical apparatus were manufactured. Among the work carried out was the lighting of Baron Rothschild's mansion, the garden being illuminated by arc lamps fixed on the roof of the mansion. Other pioneering work carried on at about the same time included the lighting of the Castle Museum, at Nottingham. Among more recent undertakings carried out by Mr. Offor's company was the electricity supply of a group of towns in the North of England, all connected with the parent company, and suggesting, Mr. Offor thinks, "the scheme for the supply of the whole country—if the Government ever carries it out." Mr. Offor was a member of Lord Thurlow's Committee appointed to consider the amendment of the Electric Lighting Act of 1882.



Elliott & Fry] [*London.*

Mr. George Offor.

Lafayette] [*London.*

Dr. S. Z. de Ferranti.

The "All-Electric" Ideal.

Dr. Ferranti, the pioneer of high-pressure transmission, in 1910 foretold a magnificent future for electricity. To Sir John Snell, Chief Electricity Commissioner, and his colleagues has been entrusted the task of hastening the realisation of that vision.

Photo by] [*Keith Dannatt*

Sir John F. C. Snell.

FACTORS OF PROGRESS IN THE ELECTRICAL ENGINEERING INDUSTRY.

By C. H. WORDINGHAM, C.B E., M.Inst.C.E., M.I.Mech.E., M.I.E.E., A.Inst.N.A.

The average man, though fortunately there are exceptions, when he reaches his fiftieth year sees looming ahead his threescore years and ten and is more than content to accept the fiat that it is the term of his activities, he is inclined indeed to set an earlier limit and to look back in preference to looking forward, to take stock of work accomplished rather than plan more triumphs. Not so a great technical journal which has seen the birth of an industry and chronicled its attainment to vast proportions and high achievements in the application of the forces of nature to the service of mankind, itself contributing not a little to this progress. In celebrating its Jubilee that journal looks forward through the youthful eyes of the giant that has arisen with confident hope for unlimited expansion in importance and usefulness in the days to come.

Already there is no branch of engineering with which the electrical industry is not intimately interwoven, the driving of machine tools, the running of factories and works of every kind, the operation of steel rolling mills, of heavy dock machinery, the winning and winding of coal, the propulsion of road vehicles, tramcars, trains on suburban and main lines, ocean tramps and liners, naval submarines and battleships. From no branch, the smallest or the greatest, is it absent.

Photo by] [Elliott & Fry.

C. H. Wordingham.

The versatility of the industry shows itself in its application to such other work as the smelting of metals, the manufacture of new products, communications by telephone, by telegraph, by light, with wires and cables and without them, equally for the purpose of peaceful business or amusement and for the warlike operations of direction of gunfire, detection of submarines and aeroplanes, and, it may be added, for their destruction.

Wherever electrical means are introduced there are efficiency, convenience, adaptability, cleanliness, and the saving of human effort.

Who can prophesy the future of an industry which has such powers and potentialities? He would be a bold and a rash man who would set a limit to them in the domain of physical possibility. More profitable will it be to consider a few of the prosaic means by which progress may be promoted.

In the forefront of the factors making for progress should be put co-operation in its broadest sense. Co-operation does not mean combination; not the setting up of huge organisations in which individuals and individual concerns are merged; not the formation of rings, trusts, or cartels. It means literally what it says, the working shoulder to shoulder, the pulling together of each and all engaged in the industry, the sinking of petty jealousies, the concentration on one's own particular field of work and the recognition that it abuts on all sides on the terrain of others. No man can live only to himself and in benefiting others by his consideration of their interests and capabilities he promotes the good of the industry as a whole from which he himself will in due time reap an abundant harvest.

Let us take a few concrete examples. There are existing a large number of engineering institutions, some of such a character that membership of them confers a certain standing on the individual and guarantees a definite minimum standard of training and experience. Others, while conferring no hall-mark, offer very substantial advantages to their members, each of its own peculiar kind. Others again, and these very numerous, do little more than provide convenient means of intercourse and discussion among their members, often in districts remote from pivotal engineering activity. One and all serve a useful purpose, but their efforts are self-contained, detached from one another, and overlapping often takes place.

In some respects it would be ideal if one grand institution with many branches, each with appropriate sub-branches, could look after the whole of the interests, scientific, technical, commercial, and material of every kind of engineering. Were a scheme for such an institution to be launched in the present state of development of the industry, but with all existing organisations obliterated, it might be possible to cover the field adequately with economy of effort and the avoidance of overlapping, but taking things as they are, such a scheme would have no chance of success and with equal certainty it may be asserted that no existing institution could be developed to cover anything approaching the ground required. What we have at present is the result of gradual growth, the accretion of many organisations founded originally because a need for them was experienced. Natural growth is healthy, and the majority of the existing associations are virile and sound in wind and limb. They could not be destroyed or their identity submerged without grave loss, but their power for good would be enormously increased by co-operation.

Fortunately this view has gained favour, and it is a matter for profound satisfaction that a start has been made by four of the leading Institutions who have already co-operated in other directions, namely, the Institutions of Civil Engineers, Electrical Engineers, Mechanical Engineers, and Naval Architects. A Council has been set up in which each is represented on an equal footing. It is true that the beginning made is modest and the functions of the Engineering Council are in no way startling. For that very reason there is hope of growth, permanence, and the eventual attainment of great power and influence. It is the over-ambitious beginning which most often proves a flash in the pan.

But things cannot stay where they are now a beginning has been made; other Institutions are of such a standing as to have a good claim for direct representation on the Engineering Council, and some means ought to be found to secure representation in some measure, indirect it may be, of the many smaller and less important bodies which are nevertheless doing in many cases extremely useful work. As a useful preliminary,

these last named are considering the banding of themselves together to form one body representative of them all. If and when such a body is formed, it should not be a matter of insuperable difficulty for it to secure recognition by the Engineering Council and get itself represented thereon, thus giving the indirect representation above advocated for the smaller fry.

It would be going far beyond the scope of this article to attempt to indicate the sphere of usefulness of the Central Council. Its opportunities and possibilities are well-nigh without limit for economy of effort, concentration of ability on specific subjects, decision on matters vitally affecting the whole industry and the attainment of objects impossible without it.

A second example of co-operation is to be found in research, and the electrical industry affords a fine example of what can be done in this direction. The British Electrical and Allied Trades Research Association owes its inception equally to the efforts of the Institution of Electrical Engineers and the B.E.A.M.A. Each had its own research committee, each was deeply impressed with the need for research, neither had at the time devoted any large sums to the purpose, and both were acutely alive to the possibility of obtaining a share of the money devoted to research by the Government and pursued independent means to secure it. At first there was antagonism, then a deadlock in regard to joint action, and then fortunately wiser counsels prevailed and the two bodies linked hands and formed the Research Association; since then they have seen eye to eye with perfect unanimity.

At an early stage it became evident that the Institution and the B.E.A.M.A. would each contribute powerfully to the success of the undertaking, but in a different way. The Institution could provide keen workers and brilliant intellects of the first rank, but had not in its power to contribute financially to any appreciable extent. The B.E.A.M.A., while numbering among its supporters men of as high an order as those sent by the I.E.E., had to provide the sinews of war in the shape of money and in some instances in kind. It speaks well for both parties and is evidence of their mutual appreciation that while paying the piper the B.E.A.M.A. is content to allow the I.E.E. a large share in calling the tune. By means of this co-operation it has been found possible to fulfil the requirements of the Department of Scientific and Industrial Research and thereby to secure to the electrical industry a contribution out of the public funds equal to that provided by its members.

Already results of far-reaching importance have been attained. In a number of directions the present state of knowledge has been surveyed and researches started, and in some cases completed, with a view to extending greatly the data available for manufacturers and to directly improving their products.

Doubts have sometimes been expressed as to whether co-operative research could be so conducted as to effect useful results. The E.R.A. has already provided abundant evidence that they are without foundation in fact. Not only can valuable work be done, but it may be asserted that, in some instances, it could have been done in no other way. Manufacturers who would not be willing to furnish information drawn from their own experience for the benefit of a single firm are quite willing to do so where the information is pooled for the common good of those engaged in their particular branch of work.

While co-operative research is a powerful aid to individual private research, it will not displace it, and in all probability much will continue to be done by the private investigation in the direction of the making of inventions breaking fresh ground.

The E.R.A. provides a most striking instance of the best kind of co-operation within the industry. Sitting side by side on its Council, Committees, Sub-Committees, and Panels, and giving of their time abundantly and ungrudgingly without fee or remuneration of any kind, are purely scientific men in the front rank, industrial engineers, consulting engineers, manufacturers, engineers from Government Departments, each contributing his quota to the general advancement. Not the least important function served by this organisation has been the bringing together of the electrical user and the non-electrical producer of materials employed in the industry, thus for the first time enabling the maker to understand exactly the needs of the buyer and the buyer the limitations imposed on the manufacturer by the nature of the material supplied.

The E.R.A. has linked itself with non-electrical bodies carrying out researches having an electrical bearing and so promoted the general good. It may safely be said that its work and its example will be fraught with tremendous results in the future, and that, properly directed, sustained, liberally financed research will be one of the most potent factors in enabling this country to maintain and increase the lead which it has ever held in engineering.

In the British Engineering Standards Association we have another salient example of co-operation attended with far-reaching and large benefits. The ground covered embraces well-nigh every branch, but the electrical has led the way for keenness and volume of work accomplished. Here again every type of man, scientific, professional, and industrial, has worked with the manufacturer to agree on points of difference and provide standards, the adoption of which cannot fail to cheapen production, improve the articles made and promote the interests of the British exporter in overseas and foreign markets.

As the field widens and the standards set up become better known and observed the importance of standardisation to advancement will be better appreciated. Just as research will enable new inventions, processes and materials to be evolved, so will standardisation enable the best advantage to be taken of discovery.

One more instance of co-operation of recent introduction, and differing in some respects from the others, may be found in the electrical industry, namely the British Electrical Development Association. Here we have the supply engineer, company and municipal, the contractor, the manufacturer, the salesman, with the professional man all working together to promote the common good instead of being ranged in mutually distrustful and sometimes hostile camps.

It is important to notice that while each of the bodies mentioned provides a common meeting ground for engineers of divers interests, in no case do their functions overlap. Moreover, as a matter of everyday practice, they help one another. When the B.E.S.A. wants researches made it invokes the E.R.A., and when the E.R.A. has accumulated the material for a standard specification it moves the B.E.S.A. to prepare and issue it. When information is required on the commercial working of a standard article, or on the need for standardisation, the E.D.A. is there to supply the information. Only those engaged in the actual working of these organisations know how dovetailed they are together and how cordial are their mutual relations. Long may this state of things continue! It is the duty of every member of the industry to promote it by every means in his power.

The part played by the Institution of Electrical Engineers in founding these bodies, which are proving so beneficial, should not be overlooked. It has been that of the unselfish mother who, having given birth to her children, nourished them and brought them to adolescence, has, with satisfaction, seen them set up independent establishments of their own. The policy is a wise one, for it means that the Institution founds organisations to carry out work which it has neither funds nor powers to execute efficiently and which is indeed outside the scope of its charter.

One of the fundamental necessities for the developing and strengthening of engineering in the future is education, and here the I.E.E. is essentially on its own ground. Not only by its papers, lectures and discus-

sions does it afford to its members the means of acquiring information of the latest practice and invention and of improving their knowledge by discussion with their fellows, but it provides a test of education by the conditions which it imposes on those seeking admission to its benefits. Tighter and tighter is being drawn the net that catches the inefficient or incompetent. Written examination or thesis alone is not relied on as a test, but full account is taken of the whole past history of the candidate. With the raising of the standard of attainment demanded, we may hope that the progress of the industry may be promoted.

The I.E.E. also takes an active part in the education of the student by the offering of premiums as an encouragement, the providing of facilities for discussion for students and the younger members and directly by co-operation with the Board of Education.

While the I.E.E. sifts carefully those who have passed through their training, it is to be regretted that there does not exist some means of sorting out those who can never become efficient engineers, by reason of lack of ability or aptitude, at an earlier stage whereby useless expenditure of time and funds might be avoided. It is because quite a number of young men who have not it in them to become engineers are annually turned out by the educational establishments that there still persists in some quarters a prejudice against the college-trained man.

It is unfortunate that the short-lived Engineering Training Organisation, into which so much enthusiastic hard work was put by the few individuals who formed the committee, was not properly supported by the engineering industry. During its short career a vast amount of useful information was got together and tabulated, and some most valuable reports prepared by Mr. A. E. Berriman. In the single volume published by the Organisation, of which only a limited number were printed, it is very clearly brought out that different kinds of training are necessary according as the individual is fitted to become an engineer in the broader professional sense of the term, or to take a secondary position, or thirdly to become a skilled tradesman. All these grades are necessary to the industry; it could not continue in being were all individuals comprised in one of the three classes only.

The professional engineer must follow a university career or take a full-time course at a technical college, and he must have comprehensive training as an engineering pupil in practical work. He will not be completely trained until he attains some age between twenty-two and twenty-four.

For the secondary positions it is sufficient for the individual, after having had a good secondary school education, to serve as an engineering apprentice. During his apprenticeship he will obtain a broad training in practical work, and by means of sufficient part-time study acquire a knowledge of the scientific and technical principles underlying his work. His knowledge of detail of practical work will be greater than that of the engineering pupil and his scientific knowledge very much less. His training will ordinarily terminate about the age of twenty-one.

Lastly, there is the trade apprentice who devotes himself wholly to learning thoroughly the handicraft of a particular vocation. He can never ordinarily attain with this training to a position in the front rank, but a wide field is nevertheless open to him.

Much less dissatisfaction and disappointment would be experienced if this classification were recognised and if it were understood that different classes of mind and degrees of ability require different kinds of training and are capable of useful work in different spheres.

A word must be given to the commercial engineer, who will have an important influence on the engineering progress of this country. It is for him to find openings for the products produced by his exclusively technical brethren. It is necessary that he should have a good knowledge of the articles which he sells and that he should be able to discuss intelligently with the prospective purchaser the details of the latter's requirements and the advantages of what is offered for sale.

Obviously for the commercial engineer whose function it is to find new markets for British manufactures a thorough knowledge of foreign languages is essential. French and Spanish will probably serve him best but in special cases other languages will be necessary.

It is greatly to be regretted that with certain conspicuous exceptions British engineers, and especially manufacturers, appear to appreciate so little the vital importance of adapting their engineering language, or, in other words, their system of measurement, to the needs of foreign powers. The vexed question of the adoption of the metric system in this country may well be left severely alone in an article such as the present one, but as to the absolute necessity of the use of the metric system in seeking to sell goods in certain foreign countries there can be no shadow of doubt. It is not sufficient to give the metric equivalent of English measurement; it is essential that designs should be worked out in round metric numbers, and that the exact metric dimensions asked for should be supplied. In certain countries, markets are now absolutely closed to British manufacturers because they are so shortsighted as to refuse to adapt their manufactures to the metric standards existing in those countries. A change in this attitude is of the greatest importance in securing world markets.

One more instance in which the blindness of those most concerned is painfully evident is in connection with what has been called a National Electrical Proving House. At the present time we have numerous standard specifications defining the conditions which articles purporting to be standard should conform to. In many cases type tests are specified; these tests aim at trying once for all whether a particular article does or does not conform in all respects to the specification. Often large amounts of power are involved and trials occupying a considerable length of time. It is only intended that these tests should be made on one article out of a great number, but it is necessary that for that one article they should be carried out by some properly-constituted authority absolutely above suspicion of bias. No such body exists, and it is practically impossible to get type tests carried out efficiently. In some cases the manufacturers themselves may conduct them, but obviously this course is open to serious objection.

A suitable institution worthy of the electrical industry ought to be established, and would be established if manufacturers could only be persuaded as to the immense commercial value that it would have for them. At present their attitude is one of distrust and apathy. It is not desirable that this institution should be under Government; it ought to be managed by a committee constituted very much on the lines of the Council of the Electrical Research Association. That is to say, it should be started and run jointly by all manufacturers concerned, the powers of the governing body being balanced by a combination of representatives of the Institution of Electrical Engineers, consulting engineers, and large users of electrical plant, such as power station engineers, railways, Government departments and electrical contractors.

Such an institution would complete the chain of the B.E.S.A., the E.R.A. and E.D.A. and would enable the members of the B.E.A.M.A. to prove their compliance with standard requirements. After advocating a National Electrical Proving House for over a quarter of a century one may appropriately say "Hope deferred maketh the heart sick, but when the desire cometh it is a tree of life."

This very imperfect attempt at indicating a few of the means which may contribute to the progress of the engineering industry in this country may fitly be concluded by an expression of profound belief in the innate engineering genius and instinct of the British race and of the hope, founded on reasonable grounds, that there awaits the British engineer a position of pre-eminence in the future even higher than in the past.

THE TREND OF PROGRESS IN COMMUNICATION BY WIRE.

Contributed by MAJOR PURVES, Engineer-in-Chief, G.P.O., and SIR WILLIAM NOBLE, late Engineer-in-Chief.

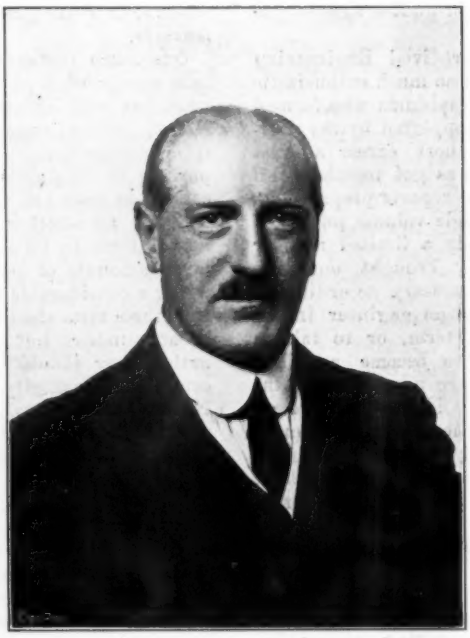
Telephony.

So long as speech remains the most effective means of transferring human thought, so long will telephony be the greatest possible achievement in electrical communications.

It was given to Alexander Graham Bell to live to see his original invention gradually and steadily developed until speech could be transmitted across a continent or across an ocean—and these developments were achieved in the comparatively short period of 40 years.

The remarkable successes which have been attained in the past decade in radio telephony have prompted some predictions that it would ultimately become the common means of telephonic communication; but the authors of such predictions have overlooked circumstances which must prevent the fulfilment of their dreams. Radio-telephony is broadcasted speech, and anyone who pleases may listen. The fundamental condition of secrecy can be obtained only in wire telephony, and the realisation of universal telephone communication for the business purposes of the world will be achieved by this means.

The most recent advances in telephony both by radio and by wire have resulted from the development of the thermionic valve from the original invention of Dr. Fleming. In wire telephony the thermionic valve has led to the solution of a problem which had previously presented apparently unsurmountable difficulties, namely, the evolution of a telephonic relay or repeater. Further than this, the thermionic valve has been the means of acquiring an extended knowledge of the laws governing the electrical transmission of speech, which could not otherwise have been gained.



Major T. F. Purves, O.B.E.

Before the advent of the modern telephone repeater the limit of speech transmission appeared to be the distance over which heavy-gauge copper conductors, loaded at suitable intervals with inductance coils, could be stretched in air on highly-insulated supports. Although the requirement never actually arose, there appeared to be no engineering difficulty in so providing international communication within the limits of the European Continent. In Great Britain the maximum possible distance between telephone stations was well within the limit referred to, and for some years after the taking over by the State of the trunk telephone service in 1896 it was possible to provide pole lines along the public roads, railways, and canals, to carry all the wires required to meet the demand for trunk service.

As the trunk service became more general and additional wires were required to carry the rapidly-increasing traffic, it became difficult to find routes for new pole lines, especially in the vicinity of large towns, and by 1910 the congestion had become serious. Already large numbers of wires used for local service in the more thickly-populated areas had been diverted to underground cables, thus setting free pole-line space for long-distance wires, but this was only a palliative measure. The time had arrived when the number of wires required to carry the traffic between centres such as London and Birmingham could not be erected on air lines, and could only be provided in underground cables. The practical problem of reducing the high attenuation factor of cable conductors had been solved by Pupin in 1900, and it was possible, by the use of inductance coils spaced in accordance with Pupin's specification, to reduce the attenuation factor of a cable conductor to equality with that of an aerial conductor of the same gauge. The limiting condition in the case of the cable circuit, which was negligible in the aerial circuit, was the mutual interference between adjacent circuits in a multi-conductor cable. The interference factor, moreover, prevented the formation of superposed or phantom circuits in long underground cables. Whereas in aerial lines a group of, say, eight wires provided six independent circuits, only four circuits could be obtained from the same number of wires in a cable: a consideration which weighed very heavily against cable lines.

The problem of interference between cable circuits had been under investigation for many years. The invention by a Post Office engineer of the "multiple twin" method of stranding telephone cable conductors was a decided advance in method, but was only a partial solution of the problem. It had been proved that the interference arose from capacity unbalances between wires due to unavoidable asymmetry in building up the wires into a cable. A practical solution of the trouble was arrived at in 1913, when a method of balancing cable circuits by a system of selection of conductors in jointing adjacent lengths was introduced by the Post Office Engineering Department. The first trunk line cable balanced by this method was laid between Leeds and Hull, and was completed in November, 1913. From that time onward there was no looking back in the provision of trunk line underground cables. A stage had been reached where it was practicable to provide underground telephone circuits up to a distance of about 400 miles, the limiting factor being the size of copper conductors which could be successfully stranded up into a multi-core cable. Conductors weighing 300 lb. per mile were found to be the largest practicable for mechanical reasons, and four conductors of this weight were included in the mixed gauge trunk cable laid between London and Liverpool and completed in 1916.

About this time, however, considerable success had already been obtained with the telephone repeater, using a thermionic valve as the amplifying element. It was found possible to construct and maintain in continuous operation under commercial conditions a repeater having an improvement factor equivalent to the suppression of a length of line equal in its attenuation constant to 15 miles of standard cable. In other words, a line circuit having an equivalent of 30 miles of standard cable could be increased 100 per cent. in talking efficiency by

means of a telephone repeater located in the middle of the line. Translated into terms of conductor weights, it meant that as between London and Liverpool, for instance (200 miles), the efficiency of a circuit with 150 lb. conductors and an intermediate repeater at Birmingham could be made equal to that of a 300 lb. circuit without a repeater.

Later experiments proved that several repeaters suitably spaced along a line could be operated in tandem. These experiments opened out an entirely new vista in telephone line engineering. It could be foreseen that very light conductors suitably loaded and weighing only 40 lb. per mile, relayed at intervals of from 50 to 60 miles by thermionic valve repeaters, could be used to cover the distance between any of the principal cities of Great Britain.

A cable containing 160 pairs of 40 lb. conductors, giving a maximum of 240 telephone circuits, has been laid between London and Manchester, and is relayed at two intermediate repeater stations. This cable is the first instalment of a comprehensive scheme for linking together all the principal centres of the country in a network of underground cables. Many other main trunk cables are now in course of construction, and two (London-Southampton and London-Bristol) are approaching completion. These cables have conductors weighing only 20 lb. per mile, designed for "four-wire" repeater working, and each will provide nearly 500 speech channels. When completed, in the course of the next four or five years, the trunk line system of Great Britain will be unique not only in respect of the invulnerability of its whole backbone system against interruption by gales and snow, but also on account of the quality of service that may be obtained. The telephone repeater will not only ensure good transmission, but because it permits the use of very light conductors, large groups of circuits will be available between main exchanges, thereby making practicable the provision of "no-delay" service such as has recently been offered to the public between London and the principal towns of the Home Counties. A "no-delay" service between London and Manchester, for instance, could not have been visualised when aerial lines only were available.

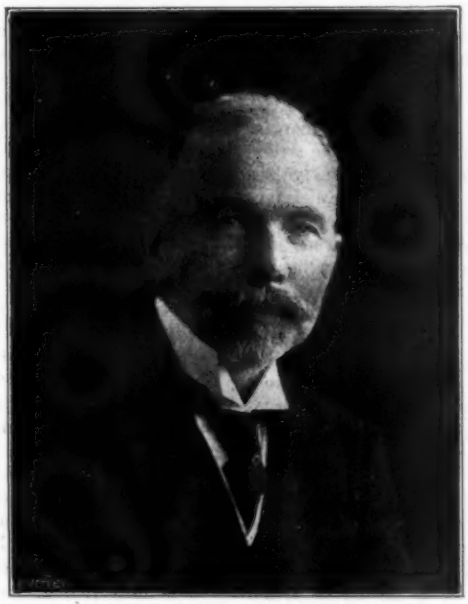


Photo by] [*Elliott & Fry.*

Sir William Noble.

The question of international communication in Europe has been raised in several quarters in recent years, and was an interesting feature of Mr. Gill's presidential address to the Institution of Electrical Engineers. Up to 1914, communication between the chief cities of Great Britain and the nearer continental cities, such as Brussels, Antwerp, Lille, Paris, Bordeaux, Lyons, &c., was maintained on quite a small number of lines, which sufficed to carry the traffic demanded by the public, but even in 1914 proposals were made for increasing the number of lines to France and Belgium and for extending the service from Great Britain to Holland, Germany, Switzerland and Italy.

Although Great Britain is far ahead of other European countries in the provision of an underground network of telephone cables, considerable progress has been made on the continent.

Holland, Sweden and Germany have already commenced the construction of cable routes connecting their principal cities, and France and Italy have similar plans in view. If it were practicable to retain aerial lines for international services, the provision of universal international service in Europe would present no new engineering problems. Some interesting administrative problems would arise, however, and will in any case arise, in controlling a line, say, from London to Constantinople, relayed in several different territories *en route*.

It seems to be clear that aerial lines will not always be available for every international requirement. Some sections must be in cable, and it is already apparent that in heavy traffic sections, such as between London and Paris, the provision of an adequate number of additional aerial lines is now impracticable, and a direct cable between the capitals is an urgent requirement. Germany has already solved the problem of laying a multicore telephone cable on the bottom of the sea.

The study of long-distance transmission through underground and submarine cables over the distances to be covered in international service has revealed new and intricate problems. A considerable amount of laboratory and field research work has yet to be done before a complete solution to these problems can be obtained.

It is a fundamental principle that a commercial telephone circuit must be a duplex. A circuit which could be used in one direction only, and which required change-over switches or other devices to be worked by the users for reversing the direction of operation, would be useless for general service.

There has never been any difficulty in providing the duplex or both-way facility in a circuit consisting of a line and the usual terminal telephone apparatus. When, however, the telephone repeater first made its appearance on long aerial lines, and the range of speech was increased, the problem of maintaining the duplex facility at the repeater presented some difficulties. These difficulties were completely solved in due course, and the great work of the American Bell telephone organisation in this connection merits warm recognition.

In applying the telephone repeater to communications through long underground cables, such as are now being laid in Great Britain, the duplex problem presented new features, but none of exceptional difficulty, and a satisfactory solution was readily obtained. Practically, the problem was the construction of an artificial balancing line which would stimulate the actual line for all speech frequencies and under all conditions arising in use.

This problem which thus arises in designing a long-distance underground telephone cable, which requires to be relayed at several points, has not appeared in long-distance communications over aerial lines. It may be described briefly as follows:—

An energy impulse sent out from a transmitter at one end of a line is not completely absorbed by the receiver at the distant end; part of the current is reflected by the receiving apparatus and traverses the line in the reverse direction, where it is again partly reflected and retransmitted until it does out. Succeeding impulses making up an intelligible sound pass through similar cycles. The reflected currents arrive at the transmitting end, where they pass through the speaker's own receiver after the lapse of a definite time interval.

In an aerial line where the electrostatic and electromagnetic factors are small, the speed of propagation of speech currents is almost of the same order as the speed of propagation of electromagnetic waves through space; the time interval between the sending of an impulse and the arrival at the sending end of the reflected portion is so small that the speaker is unaware of its reception in his own telephone. The interval would be about thirty-thousandths of a second on a line, say, from Madrid to Moscow. In a modern underground telephone cable over a corresponding length, with repeaters suitably spaced, the time interval would be of the order of one-fifth of a second; and the volume of sound produced by the reflected currents at the transmitting end would be a fairly loud echo of the speaker's own voice, creating an impression that his correspondent was interrupting him. Such a telephone line would be almost useless commercially on account of this "echo" effect. In the present state of the art, it appears that this limits the length of an underground telephone cable to about 1,000 miles. It is clear, therefore, that for communication between the extremes of Europe, say between London and Constantinople, the respective national cable networks which will doubtless be constructed in due course must be supplemented by a few main arteries of aerial lines for international services.

The circuit capacity of such aerial lines will not necessarily be limited to the number of physical loops that can be erected, as it will be possible to operate each loop as a multiplex of two, three, or four duplex channels by using the high-frequency carrier current system, which has been developed to a high stage of commercial efficiency since the introduction of the thermionic valve. The system is at present comparatively expensive in capital costs, and cannot compete with the multi-core light conductor cables previously referred to; but where long overland distances have to be covered, and the cost of physical circuits is necessarily very heavy, the system is economically applicable. It has been worked experimentally over the short cables between Great Britain and the Continent; but the factors which limit the radius of communication in telephone transmission at "audio" frequencies operate more severely against high-frequency carrier current transmission.

From what has been said in this brief summary it will be evident that the problem of commercial telephonic communication between Great Britain and America, a subject that has often been discussed among telephone engineers, presents many difficulties, and it must be admitted that no solution is yet in sight. Communication by wire, plus wireless, is possible, even if not immediately practicable, but cannot so far be regarded as an adequate commercial and economic proposition. Sooner or later, however, the dream must come true.

High-Speed Telegraphy.

High-speed telegraphy was the term applied in years gone by to such systems as the Wheatstone Automatic, wherein signals on the line were controlled by a perforated paper tape passing through the transmitting apparatus at a speed ranging up to 600 words per minute, but in practice working at from 150 to 350. Nowadays the term covers also any system in which on one circuit the number of telegrams carried is considerably above the usually accepted number for ordinary hand signalling; such, for instance, as a multiplex system, in which several operators, each working at hand speed, use the line for the fraction of a second, in turn with each other, resulting in a high rate of line signalling, and the dispatch of several messages practically at the same time, so far as the sending and receiving operators are concerned.

The highly-skilled Morse operator of 30 or more years ago is tending to die out, because of the fact that most main telegraph lines, or busy circuits, are worked by machine telegraphy of one kind or another, and there is not now the opportunity to obtain, nor the need for, the high degree of skill that existed at that time.

Skilled Morse transmission has now to a large extent been replaced by the typewriter form of keyboard, and skilled reception has been replaced by machine printing in Roman characters, either on a paper tape or on a telegraph form.

Where working by the Morse code is still desired on long or important lines where traffic is heavy, the transmission is effected by the previously-mentioned paper tape, prepared on an alphabetical keyboard perforator, and the reception is in the form of a similar perforated tape which, in passing through a second machine, selects the required letters and prints them in Roman type.

It speaks eloquently for the ingenuity of telegraph men that they have succeeded in devising mechanism to overcome the inherent disadvantages and difficulties of the Morse code for use as a machine-printing telegraph system, and we honour more particularly the names of Gell and Creed in this connection; the former for his typewriter form of tape-perforator, and the latter for his receiving perforator and tape-printer. The later designs of the Creed apparatus, in which the pneumatic power portion has been finally abandoned and replaced by electric power, have a far-reaching advantage which will probably result in a considerable extension of the use of the apparatus.

We then come to the modern Multiplex systems developed from the French Baudot system, which has been in use in France for some 45 years. It uses an equal letter five-unit code, which for manual transmission purposes is remarkably easy to learn. Reception on this system is in characters printed automatically on a paper tape, and the hardest part of the skilled work of the Morse operator is entirely eliminated.

A little more than 12 years ago the Engineering Department of the British Post Office duplexed this system, thereby obtaining double the number of channels per circuit compared with the circuits in France, *i.e.*, where the French obtained three, four, or six channels, the British obtained six, eight, and twelve. In the short period of 12 years the use of the duplex multiplex using the five-unit code has grown so extentively that it is now said to be carrying 85 per cent. of the long-distance United States telegraph traffic and some 40 per cent. of the British telegraph traffic. Its use has recently extended to our Colonies, and excellent results have been obtained in India and New Zealand, whilst Australia and South Africa are installing sets.

The great success of the five-unit duplex multiplex induced the German Telegraph Administration to adopt the five-unit code for their high-speed telegraph, which previously was worked by an eleven-unit code. This change enabled them to dispense with the costly and cumbersome photographic reception and to obtain direct ink-printed reception in Roman characters. The system is known as the "Siemens High-speed Automatic." A large number of sets have been constructed and brought into use on the Continent of Europe. The system has its limitations, but gives excellent results.

For main line working we have therefore three possibilities:—

(*a*) Duplex Wheatstone (Morse code), with Creed reception and printing.
(*b*) Duplex high-speed (5-unit code).
(*c*) Duplex multiplex (5-unit code).

All three systems use alphabetical keyboard perforators, and obtain reception in printed characters, but the first and second differ considerably from the third. In systems (*a*) and (*b*) all tapes have to follow in turn through one transmitter, and the reception is all on one receiver; whereas in system (*c*) each keyboard has its own transmitter through which the respective tapes pass regularly, and practically continuously, without having to wait their turn; while the reception is obtained on an equivalent number of receiving instruments of the page-printing or continuous tape types.

The various successful duplex multiplex systems using the five-unit code are all the same in principle, and differ only in details, chief of which are the following:—

(*a*) The allocation of the five-unit code combinations to the various symbols.

(*b*) Type of reception, tape- or page-printing.
(*c*) Method of maintaining "unison."
(*d*) Method of driving the apparatus.

Steps have already been taken with a view to obtaining international uniformity in the allocation of five-unit code combinations to the various letters of the alphabet, &c., in order to avoid duplication of plant and its additional cost and maintenance charges.

The different methods of maintaining "unison" are not of very great importance so long as they are effective and not troublesome to maintain. This applies also to the methods of driving the apparatus.

The type of reception is, however, of great importance, as it involves certain variations in the method of operating, in the design and construction of the keyboard perforators, and in the printing mechanism.

This question of page-printing *versus* tape-printing is an old one, and while great improvements have been made from time to time in the apparatus for page-printing, it is still not sufficiently satisfactory to warrant its general adoption. Continual endeavours are being made to overcome its disadvantages, and in time, no doubt, it will justify its greater first cost and higher maintenance charges.

The five-unit equal-letter code has the very great advantage of requiring much less complicated apparatus, both in the keyboard perforators and in the receiving mechanism, than that required for the unequal-letter Morse code; and when required for use as a direct hand-signalling system it is far more easily learned and entails much less manual exertion from the operator than does Morse working. Hence we may look forward to a further extension of this system, to be limited only by the economic factor of maintenance compared with available traffic. Where the traffic for disposal does not warrant the cost of supplying and maintaining machine telegraphs capable of large output, a simpler and less costly type of machine becomes necessary, reaching eventually the simple telephone circuit with its comparatively low first cost, low maintenance charges, and low operator costs, for dealing with a few messages per hour.

There are very strong and notable advocates of the high-speed automatic system, as compared with the duplex multiplex, but experience has shown that the latter is generally more expeditious, regular, reliable, and economical for dealing with ordinary commercial and private telegrams; while the former is particularly good for such work as trans-Atlantic cable service, long-distance wireless, and for newspaper work. These fields are, however, being invaded by the five-unit duplex multiplex systems, and time alone will show which system possesses the particular advantages which result in ultimate survival.

Modern multiplex systems are possessed of very great flexibility. The various channels of communication which they furnish need not all be placed at the disposal of two terminal offices, but can be readily made available for the service of other offices by extension on supplementary circuits according to the requirements of traffic. It is permissible to anticipate that methods of temporarily switching these channels one to another, in the same manner as telephone trunk lines, may be developed, and that much of the labour and delay involved in the reception and retransmission of telegrams at intermediate offices may thus be eliminated.

Looking still further forward, we may consider the possibility of an entire change in the method of telegraphy, in which perhaps telegrams may not be dispatched word by word, but by the quasi-photographic means already shown to be practicable for the transmission of drawings and pictures. Presumably such messages would be charged for, not by the number of words they contained, but by the area of paper occupied by the telegram, either written or typed. In that case the received telegram would be more or less a facsimile of the original, and would require no counting of words nor corrections. Such a system would simplify the work of both sending and receiving, and the treatment of telegraph messages would become almost as simple as the handling of a letter or postcard. At present this method is rather slow, complex, and costly, but improvements are being made in all three directions.

ELECTRICITY IN MEDICINE: ITS PROGRESS DURING THE LAST TWENTY-FIVE YEARS

By E. P. CUMBERBATCH. M.A., M.B. (Oxon.), M.R.C.P. (Medical Officer to the Electrical Department of St Bartholomew's Hospital; Past President of the Section of Electro-Therapeutics of the Royal Society of Medicine

The past twenty-five years have seen notable advances in the uses of electricity for the treatment of disease. Great progress has been made not only in the application of new methods of electrical treatment, but in the elucidation of the changes which electricity can bring about in the body. Perhaps the most striking results which have been obtained in recent years are those derived from currents which oscillate with high frequency, but the knowledge which has been gained of the changes which electricity produces in the tissues and the ways in which they are brought about represents the greatest advance, not merely in the past twenty-five years, but in the entire history of electro-therapeutics. The acquisition of this knowledge has had far-reaching effects. We can speak with some degree of certainty of the mode of action of electricity in the treatment of disease. Of the cases which resist treatment by simpler methods we can select those which electricity is likely to benefit, and can speak with more certainty of the results which are likely to follow. The outcome of this has been a gradual change in the attitude of the medical profession towards medical electricity. The scepticism, not to say contempt, with which the majority of the teachers of medicine regarded electrical treatment is passing; electro-therapy is now a recognised branch of medicine, and its value is realised.

Up to the beginning of the present century electrical treatment was mainly empirical. Physicians prescribed it for patients whom they could not cure, without any knowledge of the likelihood of procuring good results from it. Hospital patients who had failed to obtain relief in other departments were sent finally to the electrical department, in the hope that they might obtain some benefit there. The faith of the public in treatment by electricity was responsible for the existence of charlatans, and electro-therapy fell into disrepute. The time is still in the memory of a few when a doctor was regarded with suspicion if he practised electrical treatment. The past twenty years have seen a marked change. With the development of knowledge of the method of action of electricity in the treatment of disease, it has become possible to state, with some degree of certainty, the maladies which electrical treatment is likely to benefit. Although there is still the tendency in hospitals to prescribe electricity for any kind of obstinate or incurable disease, the electrical departments can show a far better "balance sheet" of success and failure. The recognition of the value of medical electricity was consummated in 1919, when the University of Cambridge established a Diploma in this subject (and in radiology). This Diploma in Medical Radiology and Electrology is the first of its kind that has been instituted, and it is interesting to note that Paris, which has a still more ancient University, has followed the example of Cambridge. A complete course of study for the examination for this Diploma has been organised at Cambridge and at the Medical Schools of London and other Universities. Be-

fore this, there had been no organised course of study, and those who wished to learn medical electrology and radiology had to acquire their knowledge mainly by their own efforts.

The extrication of medical electricity from the confusion of unscientific empiricism may be said to have commenced at the beginning of the present century with the publication, between 1900 and 1903, of a series of masterly researches by Dr. Stephane Leduc, Professor at the Medical School of Nantes, on the principles of the migration of ions and their practical application to the living body. Leduc demonstrated the possibility of the introduction of ions through the skin into the living tissues by means of the constant current, and showed that certain diseases could be treated successfully by this means. He explained the method with such clarity and practised it with such precision that doubts were dispelled, and the form of electrical treatment now known as "ionisation" came into existence and has since been practised with great success. The advantage peculiar to the introduction of ions by the constant current is the thoroughness and uniformity with which they are introduced. If a solution containing ions is placed in contact with the skin, the ions do not diffuse through the latter, while the diffusion into the skin is extremely slow. But when the current is made to pass through the solution into the body, the ions migrate through the skin and below it. Every portion of the tissue, however minute, in fact, every cell, is permeated with ions. If a solution containing ions is injected from a syringe it forms a local "puddle," which is quickly absorbed into the circulation. If the solution is taken by mouth, it is distributed to every part of the body. Some examples may be given of treatment of disease by ionisation. Ulcers, sinuses, and cavities infected by pus-forming bacteria will often fail to heal when antiseptics are placed on the surface or into the cavities. Bacteria which lie below the surface are not reached by the chemical intended to destroy them. But ions of zinc, which possess strong germicidal powers, can be made to migrate below the surface by means of the current. They destroy the bacteria, and healing takes place. Rodent ulcer, which is a peculiar form of malignant disease of the skin, can, in some cases, be destroyed by means of zinc ions. By means of the current, the ions can be made to permeate every cell of the malignant tissue and destroy it; the deal tissue separates, and healing takes place.

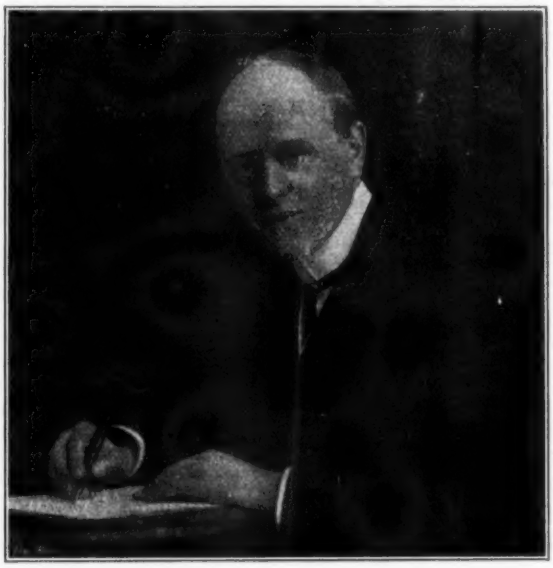


Photo by [*Vandyk.*

E. P. Cumberbatch.

There is another peculiar form of malignant ulcer which attacks the cornea of the eye and, if unchecked, spreads over the entire surface, and causes perforation. It is most difficult to treat by other methods, but can usually be healed by the method of zinc ionisation.

In addition to his exhaustive investigation of ionisation by zinc, Leduc made a careful study of chlorine ions and salicylic ions. Chlorine ions possess the power, when introduced by the current into scar tissue, of softening the latter and loosening the adhesions which it causes and restoring mobility. Salicylic ions have the power of relieving pain in many forms of neuritis. Many other ions are used now in electro-therapeutics, and possess special healing properties when introduced by the current. Treatment by ionisation was widely practised during the late war, and the value, not only of this form, but of other forms of electrical treatment, was shown incontestably to those who were inclined to be sceptical as to the powers of electro-therapeutics.

The constant current is now frequently used for the destruction of diseased or abnormal tissue. The destruction is not due to any mysterious power of electricity. As a conductor of electricity, the body behaves as an electrolyte, and when a current is passed through it by way of metal electrodes placed in contact with the moistened tissue, new chemicals are formed around the electrodes. These chemicals possess caustic properties and will destroy the tissue in the vicinity. If ready-made caustics are used, they act only on the surface, and the destruction cannot be confined to the desired region. But if the constant current is used, the caustic chemicals are made to appear in the exact spot desired, and their amount can be accurately controlled. If the electrodes have the form of needles, the caustic action can be produced below the surface. This method has many useful applications. If an eyelash grows on the under surface of the lid, thereby causing intense irritation, a fine platinum needle can be inserted into the hair follicle and connected to the negative pole of a battery. A minute current is made to flow, caustic soda is formed from the tissue ions in just sufficient amount to destroy the root of the hair, and the latter can be lifted out. The same principle is applied in a method used with success by Dr. Axel Reyn, of Copenhagen, for the destruction of lupus of the mucous membranes.

There are many other methods of applying electricity for the treatment of disease—some of them old, others relatively modern. Static electricity has been used in medicine for 170 years, and it is doubtful whether any form of treatment has been associated with more charlatanism. But it possesses undoubted therapeutic value when applied in the right way to the right maladies. Brush discharges from powerful static machines (the so-called "static breeze") have long been used for the treatment of general debility, with success in some cases, with failure in others. It is now known that the main effect of the static breeze is an elevation of the blood pressure. When directed on the surface of the body, it produces a reddening of the skin and a strong stimulation of the sensory nerve endings in the latter. These effects persist for some hours. A rise of blood pressure is the physiological sequel of the stimulation of the sensory nerve endings in the skin. If, therefore, the patient has a low blood pressure, treatment by the static breeze is indicated, and the symptoms which accompany it will disappear. On the other hand, if the patient's blood pressure is high, the static breeze is more likely to aggravate the symptoms. During the late war electrical treatment was often sought for neurasthenia. The blood pressure in this disease is usually lower than normal, and the static breeze gave the most benefit.

High-potential discharges from a wire brush or through the so-called vacuum electrodes will often heal sluggish infected ulcers. This is due to the formation, by the discharge, of ozone and oxides of nitrogen from the atmospheric gases. These have powerful germicidal action. The stimulation of the sensory nerves is followed

by the dilation of the vessels supplying the region of the ulcer, and healing is aided by the influx of a larger supply of blood. The administration of sparks from the static machine, or the application of the so-called static wave current, causes sudden violent twitches of the muscles. If there are adhesions in the region of the muscles and pain is caused by movements which require the action of these muscles, this form of electrical treatment will loosen the adhesions and restore free, painless movement. Long-standing lumbago is often relieved by this treatment. The sudden tugs of the muscles produced by the electrical discharge are readily borne if applied correctly, whereas slow contraction produced by other methods would cause intolerable pain.

The last ten years have seen great progress in the medical uses of high-frequency currents. The physiological and therapeutic properties of these currents were carefully investigated during the closing decade of last century by that distinguished pioneer, d'Arsonval, Professor at the Collège de France, Paris. Their method of action was, at first, not understood, and unscientific persons used them for all kinds of obstinate maladies. After a few years, the saying: "la haute fréquence est la haute finance," expressed the opinion of the medical profession in France regarding treatment by high-frequency currents. During the early years of the present century it was shown by German workers that these currents were able to raise the temperature of the parts of the body which they traversed, and that the heat would become intense and even intolerable if the oscillations were sustained and the strength of the current sufficiently great, *viz.*, two or three amperes. The apparatus which had previously been used for medical purposes provided weak currents of unsustained oscillation, and these produced no sensation in the body, or, at most, trivial warmth. It was gradually established that the production of heat was the essential action of high-frequency currents in the treatment of disease. Heating of the body by high-frequency currents differs in one essential particular from all other methods of heating: the heat is actually generated inside the body along the path of the current, whereas in the other methods the heat is supplied "ready made," and has to penetrate from the exterior. But as the tissues are very bad conductors, the heat does not spread below the skin. In other words, *surface heating* is produced, while, by the high-frequency currents, *deep heating* is produced. Machines capable of yielding currents of high amperage and sustained oscillation are now used, and in recognition of the all-important action of high-frequency currents, the treatment is now known as *diathermy*.

Diathermy is a valuable method of treatment of new growths—both innocent and malignant. By adopting a suitable technique, the temperature of the growth can be raised *en masse* until it undergoes heat coagulation. It gradually separates, and the residual space is quickly filled with healthy tissue, and healing is rapid. In this method of treatment there is no cutting or scraping or bleeding or the attendant risk of dissemination of the growth. The effects on the patient are surprisingly small. There is no shock after the diathermy, and even if the operation is extensive, the patient is able to sit up or leave bed on the day after, and can usually leave hospital in two or three days. Diathermy was introduced into England in 1909 by the late Dr. Lewis Jones, and the first operations were performed in the Electrical Department of St. Bartholomew's Hospital. At first the tendency was to reserve diathermy for the treatment of growths which were too advanced for surgical removal. Even in these cases the patients were made comfortable, and life was considerably prolonged. In more recent years, cases regarded as operable have been treated, and still better results have been obtained. If early cases are treated, we may be able to produce cures. For those very intractable papillomata which grow in the interior of the bladder, diathermy is now recognised as the method of treatment *par excellence*. Bleeding is stopped, the growths are destroyed, and do not recur. The non-surgical uses of diathermy, while less dramatic, are none the less effective. The therapeutic effects of heat have been known for centuries. These have been the effects of surface heating, but deep heating can produce results which surface heating is unable to effect.

From the foregoing brief sketch it will be realised that electricity owes its therapeutic value to its power of producing definite chemical, thermal, or mechanical effects in the tissues, and that cure is the result, direct or indirect, of these effects. The establishment of this truth represents the work of the past twenty years, and has opened out a new era for electro-therapy as a scientific branch of medicine. But much still remains to be done. The links which connect the immediate changes produced by electricity in the tissues with the ultimate therapeutic effects are in many cases obscure or unknown. We are ignorant of the way in which the constant current procures relief in disease of organs which lie deeply, beyond the range of effective penetration of ions from the exterior. There is a migration of the tissue ions, but we do not know what relation it has to the cure obtained in some cases, or why failure attends similar treatment in apparently similar cases. Sinusoidal and faradic currents possess therapeutic powers, but beyond the fact that they stimulate muscles and nerves, there is little known of the series of changes which connect the stimulation with the therapeutic effects. The solution of these and other problems will be aided by the study of the physiological action of electricity on the living tissues in health. Pharmacology, the study of the action of drugs on the body in health, is necessary for the intelligent use of drugs in disease. So also is the study of the action of electricity on the normal body necessary for the intelligent use of electricity in disease. Much physiological research has been done on excised muscles and nerves, but what is wanted is further investigation under the different conditions of the intact body. The future should see the physiologist working in conjunction with the practitioner of electro-therapy. The help of the physicist is becoming more and more necessary for the elucidation of the problems connected with the physics and electro-technics of medical electricity. Team work by the medical electrologist, the physiologist, and the physicist would do much to unravel the problems of medical electricity, and to benefit suffering humanity.

The next few years will see a widening of the field of electro-therapy, a much more general adoption of electrical treatment by the medical profession, and the entry of a much larger number of medical men into the field of medical electricity. They will see the establishment in the hospitals of departments devoted entirely to electrical treatment. At present some hospitals do not possess electrical departments, while in others the custom is to practise medical electricity in the same department with radiology or other branches of physio-therapy.

Each of these subjects is large enough for the complete attention of a single head of a department, especially if a medical school is attached to the hospital; and if they are united in a single department, one of them receives the chief attention, so far as original investigation is concerned, while the other remains stationary.

This brief sketch would not be complete without paying a tribute to the memory of one whose labours were almost entirely responsible for the advance in this country. The late Dr. Lewis Jones, England's greatest medical electrologist, was given charge of the Electrical Department of St. Bartholomew's Hospital in 1890, at a time when medical electricity was almost entirely neglected by the profession. An able physician and neurologist, he gradually separated the maladies which could be benefited by electricity, and out of chaos and confusion he established order. He showed how the treatment should be applied, and explained how it acted. Ionisation, diathermy, and diagnosis by condenser discharges were introduced into this country by him, and were first practised in his department at St. Bartholomew's. The therapeutic value of sinusoidal currents was established by him. His death, in 1916, was untimely, but his work had laid the foundation on which is being reared a British School of Medical Electrology.

SOME CONSIDERATIONS CONCERNING CABLES.

By B. WELBOURN, M.I.E.E.

The premier position that has been taken by this country in the manufacture of insulated cables is traceable to several causes. We were the pioneers in submarine telegraph cables, and their satisfactory working gave our engineers a firm belief in their ability to produce cables for all purposes as and when they were demanded. Again, the Board of Trade and general public feeling were opposed to the use of overhead wires for the distribution of electrical energy for many years after electric lighting and other schemes were being adopted. This attitude naturally fostered the development of insulated cables for power purposes, until they have reached the high state which prevails to-day. On the telephone and telegraph side, progress has been no less marked, especially with multiple twin transmission cables.

In the first ten years of electricity supply, underground cables were usually insulated with gutta-percha or rubber, and these in turn were supplemented by vulcanised bitumen and by impregnated paper, while some interesting examples of bare copper strip in conduit systems still survive. For interior wiring, rubber-insulated cables have been, and still are, chiefly employed, although many examples of the successful use of paper-insulated cables are to be found.

Photo by] [Elliott & Fry.

B. Welbourn.

Practice in underground power cable work has now crystallised to the extent (1) that the use of vulcanised bitumen cables is chiefly confined to collieries, and (2) that paper-insulated cable is used for all voltages of 3,000 and upwards and, on new schemes, is usually employed for all pressures. The paper-insulated lead-sheathed cable was first made available in this country in 1890-91 through the enterprise of the Brothers Atherton, at Prescot, and it has since been adopted extensively in all countries. In this country it received a great fillip through Dr. Ferranti's enterprise in building the well-known 11,000-volt concentric Deptford to London cable; this was supplemented in 1896 by a lead-sheathed paper-insulated cable supplied by the B.I.W. Co., which has been in continuous use ever since.

The next important move came in 1905, when the Newcastle Electric Supply Co., on Mr. C. H. Merz's advice, decided to install an extensive transmission system of 20,000-volt, 3-core cables. The satisfactory experience with these paved the way for the development of 3-core cables to work at 33,000 volts between phases, and one can confidently say that these are so successful that 3-core cables for higher working voltages will be available when the need for them arises. The use of overhead transmission lines with 3-phase voltages of 66,000 V and 110,000 V will bring a demand for cables for negotiating railway and Post Office crossings, &c. The latter pressure certainly suggests single-core cables, and there can be no doubt that they can be used on earthed-neutral systems in short lengths. The use of single-core high-voltage cables in long lengths has not been favourably regarded in this country because of the inherent difficulties; and the experiences lately reported from the European Continent are not likely to encourage engineers to "look for trouble" here at any early date.

It is not, perhaps, too much to claim that the reliability of cables has been the backbone of electricity supply in Great Britain in that they tided over the situation at one period when extensive scrapping and renewals of generating plant were in progress. This reliability of the mains systems has, in general, been due to various causes:—

1. Good cables, particularly those with paper insulation.
2. Careful design and workmanship on joints and the use of expansion joints in subsidence areas.
3. Great attention to the details of laying and subsequent maintenance.
4. The gradual elimination of the practice of installing d.c. networks and the increasing use of a.c. distribution — particularly 3-phase, 4-wire.
5. The care taken not to overload the cables, and thus to restrict the working temperature of safe limits.
6. The study and application of the measures which are required to prevent electrolysis of the lead sheathing of cables from stray currents.
7. The use of armoured cables laid directly in the earth, wherever practicable, and as far as possible the elimination of cables drawn into ducts.
8. The design and application of automatic apparatus for the instantaneous elimination of faults between phases and to earth on high-voltage cables.
9. The increasing attention paid to keeping down dielectric losses to low values over the whole working temperature range of high voltage cables.
10. The fact that nearly all engineers have adopted the dielectric thicknesses which have been published by the British Engineering Standards Association from time to time and have not been misled by statements of foreign origin as to the thinner dielectric thicknesses which might be used. In the current phrase, British engineers have preferred "Safety first."

As evidence of the reliability of networks—especially a.c. networks—which have been properly designed and constructed, it can be stated with certainty that one a.c. system, laid down 20 years ago, has never had a fault on it, and another, of about the same age, has only had two faults, both of which were due to mechanical failures at a railway crossing.

In addition, it is well known that the most progressive cable manufacturers in this country have been constantly engaged in working out improvements, many of which have already been adopted in current practice. Their individual work is being supplemented by the research into the heating of buried cables, which is being conducted by the Electrical Research Association, whose first report was published in the *Journal*, I.E.E., Vol. 59, No. 298, February, 1921, and fully discussed.

Having thus briefly stated the present satisfactory technical position and the causes that have led up to it,

we are now at liberty to adopt the Editors' motto for this Special Number and "Look Forward." What are we to look forward to? How soon will the present post-war bad trade period pass away and make increasing demands on our electricity supply authorities? When it does, will they be ready with plant and mains, and will the money market provide the wherewithal?

One hopeful sign is that it is the common experience of the supply authorities that there is no indication of suspension of the demand for new electric lighting consumers to be connected up. One authority is connecting up regularly at the rate of 170 new consumers per week, and the laying of a new distributor cable brings in fresh applications by the handful. The main reason for optimism, however, is not to be found in our own country, but in other countries, such as Holland, France, Canada, the U.S.A., &c., &c., where it seems impossible to keep abreast of the demands. Without going into many wearisome statistics, let us consider the following few facts. In California, which has a population of only 3,426,536, the number of consumers was 843,011 at the end of 1921, with a connected load of 2,959,413 h.p. The total investment of the supply authorities was $448,669,330 (say, £100,000,000 sterling), and the sales were 2,662,653,511 kilowatt-hours, or 777 kW-hours per head of population, *i.e.*, about five times greater than the corresponding figure for London and Greater London, including the kW-hours used for transportation service. In Chicago, with a population of 2,700,000, the total kW-hours in 1921 were 1,928,271,940, or 714 per head, while the number of new consumers added in 1921 alone was 62,287. In Toronto, with a population of 400,000, the number of consumers has increased in the last 10 years from 12,000 to 80,000. As the number of water services in that city is 110,000, that figure probably represents the possible number of consumers before saturation is attained. Similar figures could be produced for New York, Boston, Montreal, &c., &c., and from them all it would seem that electrical engineers in our country can look forward to a boom at no very distant date. The plain fact of the matter is that electricity has become a daily necessity in some other countries and is rapidly becoming so here. What we need to do is to develop the "electrical habit" and to cater for it. In addition, there is coming to our aid the general recognition of the wasteful methods by which we are using up our chief natural and irreplaceable asset—COAL—and impatience with the pollution of our atmosphere, with the consequent destruction of our health and our buildings, &c. In fact, conservation of coal is as necessary to our national well-being as pure air is to the health of our densely-populated country.

Let us assume, then, that a better time is coming and that the demands on the electricity supply stations will be comparable with those already mentioned. How will the situation be dealt with? The gas interests are deeply entrenched in this country, and they possess ample funds, for the most part, with which to put up a big fight if necessary. Why fight, however? Would it not be possible for the electricity interests to do as they have done to a considerable extent in Holland, America, and Canada, and recognise that the gas people can handle a good deal of the long-hour heating load? The electrical interests will have their hands full with the rapidly-developing industrial power loads, electric lighting and domestic utility loads while they are waiting for the slow but sure conversion of the railway companies to suburban and main-line electrification.

How are the dense loads of the future to be catered for, bearing in mind that in many of our towns the streets are narrow and tortuous and are already congested with gas and water pipes, electric cables, sewers, &c.? The problem can be considered from various points of view, including transmission and distribution.

1. In country districts, overhead transmission at 66,000 or 110,000 volts will be employed, and will probably suffice for the distances over which trunk lines will be economical, although 150,000 volts or higher may become practicable as our atmosphere becomes cleaner.

2. Inter-urban supplies will probably be given by underground cables at the highest economical voltage for which cables can be built.

3. The pressures at domestic consumers' terminals are not likely to be raised above the present 250-volt limit.

4. Extra room will be required in the streets of towns for cables. The difficulty of finding sufficient space for them in the streets of many of our cities is already well-nigh insuperable. It seems obvious, then, that different methods will have to be employed, and it seems worth while to examine what can be done with cables.

A. There will probably be two distribution voltages:—

(*a*) 33,000 or 44,000 volts for some years to come, with the hope that some higher-voltage cables will ultimately be available for general use.

(*b*) A subsidiary pressure at the generator voltage, which will thus avoid in part the use of step-up transformers.

The main 33,000-V, &c., cables will preferably be run as ring mains to connect sub-stations together, and they will be controlled by instantaneous automatic protective apparatus. The subsidiary mains will be worked at 3,000, 5,000, 6,000 or 11,000 volts, and will form local rings or direct supplies. It seems to be evident that there must be a reversion to a modified form of the old house-to-house idea, with frequent transformers.

B. Where the loads are dense, it will not be practicable to multiply low-voltage distributor cables, and it seems to follow that fewer cables at one of the subsidiary pressures mentioned in A (*b*) above will be used, and that the use of low-voltage cables will be reserved for short-distance work, for suburban streets, &c.

Under our conditions, it seems to be inevitable that a.c. must largely displace d.c. distribution, especially as the loads increase.

C. Where and how is street-space to be found for the cables and what type of cable is to be used?

In country districts and in suburban streets, it has been well established that a properly armoured cable laid directly in the earth gives the best all-round results, but this type is not always suitable for use in congested streets. The time is already with us in many streets when cables can no longer be laid amid the existing maze of pipes, &c., and they cannot be laid beneath them because of the need of accessibility. The situation needs vision, courage and bold measures. In one town, in which the municipality owns and operates the electricity, tramways, water and gas undertakings, a large culvert has been constructed under the main street to contain all the chief cables and pipes. A similar scheme is suggested as being suitable in many other towns, and although the expense is no doubt great, it will become greater the longer it is postponed. Here is a chance for the electric supply industry to help in giving really useful work to the unemployed. The heat from the cables would have to be got rid of, and some experimental work would be needed to settle how far this could be done by ventilating shafts and how far it would be necessary to circulate air by motor-driven fans. The whole problem needs "ventilation," and perhaps the Editors will invite discussion on it.

Mention was made earlier of 33,000-volt, &c., transmission cables, and there may be those who are nervous of employing them after having experience only of cables up to 11,000 volts. In the first place, there have been many years of altogether satisfactory experience with 20,000-volt, 3-core cables. Experience with 33,000-V cables has not been so considerable, but there is every reason to believe that those in use are proving reliable, while switchgear manufacturers have standardised their designs for that voltage. In fact, the switchgear situation seems to be the chief difficulty in the adoption of 44,000-volt 3-core cables, which some manufacturers now consider to be feasible. A very satisfactory feature in the production of high-voltage cables in this country has been the attention which has been paid to the reduction of dielectric loss to values which are nearly negligible. This augurs well for the development of higher-voltage cables in the future, as there can be little room for doubt

that high dielectric loss and self-destruction of the cable are synonymous terms. As illustrating the lead that this country possesses in the manufacture of 33,000-V cables, it may be stated, from information just to hand from America, that such cable is now being produced and sold there under a guarantee for the power factor of the dielectric losses which is 100 per cent. higher than has been realised here on a large commercial scale.

The thermal resistance of paper-insulated cables has been brought into much prominence by the values published in the B.E.A.I.R.A. Report, already mentioned. The values obtained for so-called 20,000-V cables showed a high degree of excellence.

Emphasis is laid on these features of modern three-core cables to bring out the point that they are very reliable, when properly installed, and that there is, therefore, much less need now to lay spare cables in the interest of "security of supply" than there was in the earlier period of electricity supply. The cable makers are thus contributing their quota to the development of the supply business and are making it possible for the authorities to use the minimum amount of street space.

Much interest has been felt in the tendency in some other countries to use single-conductor cables for high-voltage transmission work over long distances, but, in view of the information that has reached this country about the resulting troubles, it does not seem likely that the practice will be adopted here until the technical problems have been more fully investigated and until it has been shown that the limit has been reached in three-core cables. The single-core cable cannot be armoured for a.c. transmission work, and some means of satisfactory mechanical protection must be provided for it. It would seem that the chief reasons for attempting to make use of such cables are:—

1. The long lengths in which they can be made.
2. The simplicity of the joints.
3. The thickness of dielectric that can be employed.
4. The larger blocks of power that can be transmitted.

In the past it has been obligatory under the Board of Trade Regulations to pressure test all cables after installation before putting them into commission. Many years' experience in this practice goes to indicate that the testing is unnecessary with modern cables and jointing methods, and that the money spent over it is usually wasted, even at the highest voltages. With long lengths of 20,000- and 33,000-volt cables the prescribed a.c. pressure test is impracticable because of the large kVA required, with the result that resort is made to d.c. testing with Delon and Kenotron apparatus, which cannot be so searching as a.c. tests, because no dielectric loss is developed other than that by conductance.

The nomenclature of cables also needs reconsideration. The Board of Trade regulations state that all pressures above 3,000 volts shall be deemed an extra-high-pressure supply. Our ideas of "extra high pressure" have progressed much since the 1909 revision. Overhead lines are at work in the U.S.A. at 165,000 volts, and others are under construction for 220,000 volts. In this country 11,000 and even 20,000 volts are coming to be considered as being really distribution pressures, and it might not be inappropriate to suggest that the term "high pressure" should be extended to include all voltages below 30,000 V, and that extra high pressure should be reserved for all higher voltages.

The manufacture and methods of installing balanced multiple twin cables for telephone transmission have undergone very considerable improvements since 1912, when the General Post Office commenced their new scheme of underground transmission. The different types of cables, together with the results obtained by loading the physical and phantom circuits with Pupin coils, have been fully described in the Post Office "Journal." These records indicate the great reduction in the sizes of the conductors which has been found to be practicable, particularly since thermionic valve repeaters have been brought into use. One result has been that a largely increased number of pairs of conductors can now be placed in a lead sheath of given diameter. From the user's point of view, the main results of the use of balanced underground cables are the much greater reliability of the service, especially in stormy weather, and the "silence" of the lines.

Historical Note.

Much prominence has been given this year to records of early electrical history in this country, but so far I have not seen among them any specific statement regarding the work done in England on dielectric loss in insulated cables. It will not, therefore, be out of place to take this opportunity of putting on record that the subject received early consideration in this country, particularly in Mr. W. M. Mordey's paper on "Capacity in Alternate Current Working," read before the I.E.E., January 10th, 1901. In the discussion, Mr. C. P. Sparks gave important information regarding the practical tests which he had made on installed underground cables while, when replying, Mr. Mordey recalled a statement made by Mr. James Swinburne 10 or 11 years earlier at the Physical Society regarding dielectric loss in the Deptford paper-insulated 11,000-volt cables.

ELECTRICAL MACHINERY AND TRACTION.

By Prof. STANLEY PARKER SMITH, D.Sc., M.I.E.E., Assoc.M.Inst.C.E.

About the beginning of the present century the electrical trade in this country was in an interesting, though unsatisfactory, position. England's supremacy had already been successfully challenged, partly, it must be confessed, in consequence of her failure to keep abreast of developments. Compared with the large electrical firms abroad, ours were generally small, while technical directors were almost unknown. Moreover, many large foreign firms had established manufacturing branches in this country, and others had established active selling organisations. In face of this fierce competition, bad trade was all that was needed to make the position appear hopeless.

Under such adverse conditions it is surprising that developments should have prospered in this country at all. Yet progress was made, and instead of yielding place to large foreign combinations, British firms united and grew in strength, with the result that at the present day Great Britain possesses on the one hand manufacturing firms able to compete successfully against all rivals, and on the other hand schools holding the foremost rank in the training of engineers.

The trend of development in heavy electrical engineering has ever been greatly influenced by the battle between alternating and continuous current—a scientific conflict as perennial as the political conflict between the French and the Germans. In the early days of electric lighting, the single-phase alternator and stationary transformer formed an important stage, and gave ample opportunities for trying out various values of x, where x denotes the frequency of supply. As commutation phenomena began to be understood and the troubles associated therewith overcome, continuous current forged ahead. The position of continuous current became more firmly established by the spread of the three-wire system with the increasing demand for power on the one hand, and on the other by the advent of the carbon brush, and the commutating pole.

During this active period of continuous-current development, alternating current had likewise moved for-

ward. Already the limits of continuous-current supply were being reached on account of the voltage restrictions imposed by the commutator, and there was sufficient inducement to direct attention to alternating current, particularly where the utilisation of water power was concerned. Here, again, phenomenal success was achieved, though unfortunately this country was not the leader. The lack of water power and the wide distribution of coalfields in Great Britain retarded development considerably. Though in the construction of alternators and induction motors this country can now claim to be in the forefront, high-voltage transmission plant has made more progress abroad than at home. If, however, the pride of place cannot be given to us in the development of alternating-current work, and if alternating-current theory was not as popular at one time in our schools as in those of other countries, the pioneer work done in connection with steam prime movers well deserves mention.

The steam turbine came into practical use at the time when continuous-current generators were yet in wide demand, and the resources of the electrical designer were severely taxed. For a long time the difficulties of commutation in the continuous-current turbo-generator seemed almost insuperable, and few progressive firms escaped without serious loss. Nevertheless, success was achieved; but just as 1,000-kW units became feasible, other methods of producing continuous current became available. By a strange coincidence, Parsons, the pioneer of the steam turbine, developed reduction gearing for large powers. A still greater rival than the geared dynamo, however, was the rotary converter. With the successful development of the turbo-alternator and the 50-cycle rotary converter, the much-feared continuous-current turbo-generator went out of fashion, and it is now only in demand for ship lighting or other special services. The rotary converter, as we know it, is largely a British product—foreign influence in this connection has had but little useful or permanent effect.

Photo by] [Elliott & Fry.

S. Parker Smith.

The increasing demands for electric power could only be satisfied by the large unit and high-voltage transmission. This gave a further impetus to alternating-current work, and a blow to the comparatively small c.c. generator. But with the possibility of generating alternating-current energy, there at once arises the demand for alternating-current motors. To convert into continuous current is a compromise that will be avoided where possible. This demand, however, again raises the conflict between alternating and continuous currents, and brings us to the problems of to-day.

When we consider the influence which the electrification of railways may have, very conflicting views are met with. Ignoring the views of those who are definitely allied to certain interests, there remain facts which are hard to explain. The development of the high-voltage continuous-current system is being advocated with the same ardour as the development of the single-phase system. While Switzerland, Germany, Austria, and Sweden use the single-phase system at 15,000 volts and $16\frac{2}{3}$ cycles, Great Britain, France, Belgium, and Holland officially advocate the 1,500-volt, continuous-current system. Whether railway electrification will ultimately influence the decision of alternating *versus* continuous current, time alone can show; but any extensive development of electric traction will have a marked effect on the electrical industry, owing to its magnitude.

Closely allied to the problem of alternating-current generation and transmission is that of power-factor correction. Now, while the induction motor solves the motor problem in the majority of cases, it aggravates the power-factor problem. It is the complications which arise in solving these difficulties that re-direct attention to continuous current. The plain induction motor cannot give economical speed control, and the manifold devices for obtaining this require in many cases commutator machines. Also certain devices for improving the power-factor entail the use of commutators. On the other hand, the progress made with alternating-current supply has been so extensive and the success achieved has been so considerable, that any rival system which ousts it will have to be sound in every respect.

Having considered briefly what has been achieved in the past, we may now attempt a glance into the future. For this purpose the several types of machines may be reviewed separately in connection with some of our unsolved problems.

The continuous-current machine offers such remarkable advantages — particularly as a motor—that it is hard to imagine how we could do without it, especially where speed control is required. In cases where the load conditions are very severe, a compensating winding, to neutralise armature reaction, may be added. But while it may be said that the control of winding engines and reversible rolling mills has been satisfactorily solved technically by the Ward-Leonard continuous-current system of speed regulation by voltage control, commercially the solution is far from satisfactory. The need of a converting set to change the three-phase into continuous current, and of a heavy flywheel to reduce shocks to the system arising from load fluctuations and to enable the motor to cope with peak loads, renders the system costly, complicated, and wasteful. Thus for large reversible drives it has become an urgent problem to find a means of utilising economically the electric energy in the form in which it is supplied. Already, however, we may hope to regard the flywheel as obsolete in this connection. Nothing could better demonstrate the backwardness of electricity supply than the need of a flywheel to reduce shocks. With the advent of the large supply network, the flywheel, slip regulator, &c., ought to vanish; and it ought not to be long before the entire converting set becomes obsolete.

With regard to the low-voltage, continuous-current generator, the unit in the near future will either be coupled to a water turbine, or will probably be one of a suite of machines geared to a steam turbine. The speeds of such dynamos will give frequencies exceeding 50 cycles per second, necessitating special arrangements for suppressing eddy currents in the armature conductors; shrink rings will be necessary to strengthen the commutator; and the average voltage between commutator segments will have to be pushed to high values. In the more distant future the commutator may be superseded by other—possibly stationary—devices.

Passing on to alternating-current generators, it may be said that the turbo-alternator has now established its position, and it is possible to consider what direction future developments will take. Hitherto attempts to increase the size of the unit have become almost a craze, but this is not likely to continue. At last the demands of the turbine maker appear to have been satisfied, for the output which he can now get brings him to a fairly flat part of his consumption curve. Moreover, it is unlikely that the station engineer will need much larger sets than are now available. If 100,000 kilowatts be a satisfactory station load from the efficiency standpoint, obviously 25,000-kW sets are more suitable, particularly as regards spares, than 50,000-kW sets. The near future, then, may well see a greater demand for 25,000-kW sets at 3,000 r.p.m. When, however, 250,000-kW stations become feasible, the 50,000-kW unit may be in place. While for the 3,000 r.p.m. machine the solid rotor is likely to become more and more universal, it is not easy to predict any standard construction for large 4- and 6-pole rotors. But the last word has not yet been said about the large 2-pole rotor. Casting, forging, annealing, and tempering such large masses of steel still present many difficult problems, as does also the cover for securing the rotor end-windings, to the steel maker.

It may not be out of place to say a word about cooling, as this has become one of the limiting factors in large machines. As yet, air has been the predominant cooling medium, though water has been tried both for stator and rotor cooling. It is doubtful whether water will prove a satisfactory solution. On the one hand, there is always the danger of condensation under certain conditions; on the other hand, there is the danger of leaky joints. Over and above all, there is the question of cost—will a water-cooled machine prove cheaper than an air-cooled machine? As regards air-cooling, a knotty problem arises. Town air is dirty, and must be cleaned before use for ventilating machines. Without going so far as to say that both dry- and wet-air filters have proved failures, the fact remains that numerous attempts are being made to dispense with them. A system now coming into use consists of the circulation of the same air through the machine and a cooler. The heat removed from the air by the cooler may then be utilised for heating feed water, &c. It is likely that the use of this method will be extended, for it possesses the further advantage that, the quantity of cooling air being comparatively small, it is unlikely that much damage would be done to the machine by the cooling air in case of fire. Nevertheless, it is probable that other cooling media will be experimented with, in order to reduce the large volume of ventilation channels at present required in the machine.

One direction in which further improvements will be sought in large machines is in discovering means for reducing eddy-current losses in the armature conductors. Unless steps are taken to suppress these parasitic currents, excessive local temperatures may result and the safety of the machine be endangered. Following A. B. Field's classical analysis of the losses caused by the slot-field, numerous means have been devised for reducing eddy losses to a permissible value. In general, most of these devices entail a loss in rigidity of the conductors, and much work remains to be done to ensure the safety of the stator winding under all conditions, normal and abnormal. Likewise, strange as it may sound, core construction will improve as time goes on. Not only will greater use be made of high-resistance steels manufactured to satisfy practical needs still more than at present, but greater care will be taken in handling the plates and building the cores.

In order to see what direction future developments may be expected to take, we may consider what matters give rise to anxiety at the present day. As stations increase in size and networks extend over greater areas, the importance of reliability increases rapidly. Engineers seek to safeguard their systems in two ways—one by means of protective devices, the other by installing plant that will not break down. The latter ideal is the right one, and even if it be an unattainable ideal, it is probable that greater safety will be secured in this way than by the extensive use of protective devices. It is likely, therefore, that future machines and transformers will reveal sounder design, better workmanship, and a higher factor of safety than those to which we are at present accustomed. This must not be regarded as conservatism, nor as covering up faulty design with ample material. A cooler and stronger generator becomes all the more essential as the system grows and develops in importance. Generating plant must be made to withstand whatever may occur, without the aid of complicated protective devices. The idea of an interruption of service being caused by a machine fault must become as abhorrent to the manufacturing as to the operating engineer.

Coming to the induction motor, we find on the one hand a machine much liked by the user, because there is no commutator to give trouble; and disliked by the supply authority, because of the low power-factor. One solution of this difficulty is already in evidence—the synchronous-induction motor. The phase advancer is another solution. It is when speed regulation is needed that the real difficulty begins. Avoiding the use of a commutator entails loss and an undesirable speed-torque characteristic. To use a commutator robs the induction motor of its charm of simplicity. Nevertheless, the commutator will have to be accepted in one place or another to meet some requirements. Either an alternating-current commutator motor must be used, or an induction motor with an auxiliary speed-regulating set. For small and medium powers, it would seem that, in addition to the several types of variable-speed induction motor as developed by Hunt, Creedy, and others, there would be an assured future for the three-phase shunt motor with double movable brushes (due to Schrage) and various types of single-phase shunt and series motors. For raising or lowering the speed of large induction motors over a limited range, an auxiliary set consisting of a three-phase commutator machine coupled to an induction machine (due to Scherbius) is finding increasing use. Further, as an alternative to the inefficient and costly Ward-Leonard conversion, the plain induction motor with resistance control is gaining in favour, despite the rheostatic loss.

The rotary converter next demands attention. Will it survive, or will it be ousted by the mercury rectifier in the same way as it ousted the continuous-current turbo-generator? At least this can be said: if a static converter should eventually prove a successful rival, it will not be because satisfactory rotary converters could not be built. Except for flashing over on short-circuit, the rotary converter may be said to be a satisfactory machine; while means for preventing flashing over have already gone a long way to ensure safety. Its potential rival, the mercury rectifier, is just emerging from the experimental stage, and may have a great future before it.

Had the mercury rectifier been commercially developed before the single-phase series motor had become a thoroughly satisfactory machine, it is possible that much less would have been heard of the single-phase system for traction. Actually, however, the single-phase series motor has progressed so rapidly that these motors are now being built for larger outputs for traction than are continuous-current motors.

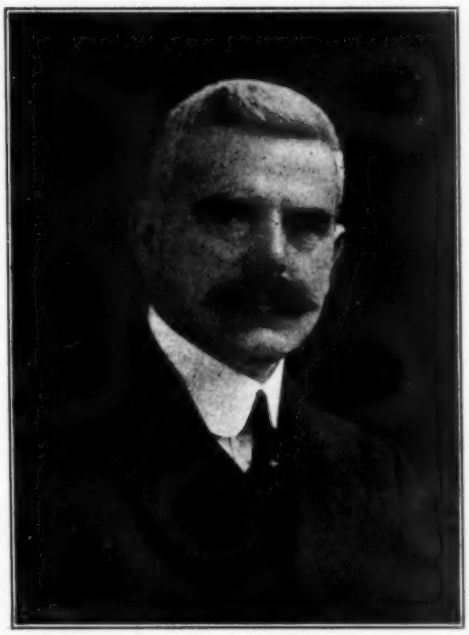
Enough, however, has been said to show that, both for general purposes and for electric traction, the battle of the systems is being waged as fiercely as ever. Rapid developments are seen on all sides. No sooner does the mercury rectifier render it possible to equip automatic sub-stations without moving machinery, than the automatic sub-station with induction generators on the one hand, and the open-air transformer sub-station on the other hand, remind us that neither system has reached the end of its resources.

Many investigators are at work, and it is certain that the successful developments of some of the projects, *e.g.*, the ionic conduction of large currents, would have a profound influence on the electrical industry.

THE FINANCE OF THE ELECTRICAL INDUSTRY.

By J. S. HIGHFIELD, M.I.E.E., M.Inst.C.E.

It is a great pleasure to congratulate the Electrical Review on attaining its fiftieth year of useful work. It has served the industry well, and it is pleasing that in recent years the important part filled by a well-informed Press has been better understood. I am convinced that the technical Press should keep in the closest touch with the needs of the industry and that it should be given every help and assistance in its work. The late Mr. Gatehouse, whom I am glad to remember as a good friend, did valuable work in this direction. I often wish that in every issue a really popular article could be inserted in technical papers written with the object of interesting the ordinary man and informing him in the simplest terms about the electrical industry. These articles should advise him how electricity can serve his ends, giving particulars of first cost and annual cost of new apparatus. The articles should explain and describe in plain terms interesting matters about power stations, wireless matters, and, in short, any matters relating to electricity. I believe a weekly article of this sort would tend to enlarge circulation and would benefit the industry to making better known its applications.



J. S. Highfield.

It is manifest that all money that comes to the electrical engineer comes from the public who buy his wares, and the important matter is first and foremost to increase the number of those who use electricity and at the same time to show how it can be employed to the best advantage so that each may increase his use of it.

The ordinary householder is usually very ignorant about the right means of using coal, gas, or electricity; there are any number of people to advise him, but usually each one can help in only a limited sense.

The applications of electricity are continually increasing, but it is not yet a universal source of household energy, and I am glad to note that many electrical engineers are interesting themselves in the problem of domestic heating and lighting in all its aspects. I am sure that the more they establish confidence in their ability to deal with this problem as a whole the better will it be for themselves and for electrical engineering generally.

The increased interest in the commercial aspect of electrical engineering, fostered by such bodies as the Electrical Development Association, is doing good. Before the war the chief argument with the public was often one based on cheapness. Electricity was sold below cost price. Municipal undertakings were working with too small margins, and company undertakings were paying inadequate dividends and starving reserve. Manufacturers were selling plant at prices that left no adequate profit. Consequently, salaries were too low, and there was insufficient money for development. All the money to pay for plant, to pay for raw material, and to pay wages and salaries comes from the consumer, and if prices are unnecessarily reduced it follows there is less money for all these purposes. On the other hand, if prices are maintained at too high a level, the demand is restricted. The proper balancing of these two opposed principles is the most important problem to be solved in business. During the war the increased cost of all commodities resulted in corresponding increases in the price of electricity. The reductions in cost of commodities during the past year, together with more economical working, have resulted in a considerable increase of prosperity in electricity supply. The beneficial result is that the industry can now raise capital with relative ease, and is making progress in consequence. Reductions in prices are being made, and electrical supply engineers for the first time in their lives are now in a position to "discard from strength." I hope that prices will not be wantonly reduced, but will be reduced so that the increased trade that should result will lead to larger profits and to money being available not only for increasing the prosperity of electrical engineers, but for research and development, so that with the improvements resulting, the cost of production can be steadily reduced. To run any business at a profit continuously requires much skill and prudence; to use the profit properly, when earned, requires more prudence and equal skill, and I hope electrical engineers will take good care to see that they do not throw away any profit by unnecessary reductions in price. The result of such foolish action is necessarily to restrict development, and in the long run the public must pay a higher price.

In asking me to contribute to this Jubilee Number, a request with which I was delighted to comply, the Editors suggested that I might deal with certain technical developments that may be of growing importance in the future. I would gladly have done so, especially as there are many most interesting matters that require discussion. I am sure, however, that at the present time the financial aspect is of the first importance. All these developments require capital, and capital is created from profit; it is the accumulation of profit. For the first time for many years electricity supply is earning profit, and if by prudent care the profit is maintained and increased the future of the electrical industry is assured in all its branches, for the profit earned in electricity supply provides the sinews of war for the development and manufacture of improved machinery both small and great; without the profit this development is impossible.

During my years of office as President of the Institution of Electrical Engineers I have met in the most delightful circumstances members of the Institution and other engineers in all parts of the country. I have been very much struck with the great feeling of confidence in the future in spite of many depressing facts, and I have been very pleased to note the wonderful loyalty to, and pride in, their profession, and the interest taken by so many in general affairs. I think the growing interest of engineers in general affairs is all to the good, and that the remarkable growth in the membership and influence of the Institution during the last ten years has helped and is due to this interest in wider responsibilities.

ELECTRICITY SUPPLY IN THE UNITED STATES.

By FRANK W. SMITH, President of the National Electric Light Association.

There are certain marked differences of electrical practices between England and the States which it is necessary to call to mind, and if I seem to glory in the accomplishments of the American companies, it is not with any thought of being boastful or of disparaging what has been done elsewhere, but with a consciousness that from those to whom much is given much is expected.

In any comparison between electrical practices in Great Britain and in the States one must always bear in mind the differences between the divisions of the race in temperament and in habits, the greater density of population that obtains in Great Britain and the much vaster territory covered by the United States. In the States the electricity supply companies are privately and to a very small degree only municipally owned. Membership in the National Electric Light Association, however, is confined exclusively to privately-owned utilities, and the extent to which private initiative and enterprise dominate is indicated by the fact that the privately-owned utilities produce 9/ per cent. of all the electrical energy generated by electric public utility undertakings of all kinds. The 110,000,000 inhabitants of the United States are scattered over an area of 103,000,000 square miles, whereas the 41,000,000 inhabitants of Great Britain occupy 88,000 square miles.

We have just celebrated in the United States the fortieth anniversary of the first electricity supply undertaking, September 4th, 1882, being the beginning of Edison service in New York City. In an acknowledgment to Mr. Thomas Alva Edison, in commemoration of that event, the New York Edison Co., over the signature of its president, Mr. N. F. Brady, made the following statement:—

"What has been achieved in the past will continue to constitute a series of stepping stones to still greater accomplishment in the future. No effort will be spared to secure this result. Nothing else would fulfil our obligations to the people of this city. Nothing else would be in keeping with the spirit that has pervaded the life work of the great man whose name we are privileged to bear, and to whom we desire to express our feeling of deep and lasting appreciation and indebtedness. We wish him many years of life and health, and of continued service to his fellow-man."

To-day the United States possesses over five thousand operating companies serving approximately fifteen thousand communities, and the total rating of these stations in round numbers is fifteen million kW. The output of electrical energy from these stations last year was forty-three thousand million kilowatt hours. The investment in electricity supply undertakings approximates one thousand million pounds sterling, and the securities are held by over 1,600,000 investors. The number of investors is rapidly increasing.

Political ownership in the States is not unlike political ownership elsewhere. Experience has proved in America what certain of your own statesmen have found to be a fact in England, that it is more difficult for Government to save a shilling than to spend a million. For that reason we have clung tenaciously to Anglo-Saxon tradition and fought all encroachments of bureaucracy. We have resented all political interference and insisted on freedom for self-development. Through the sale of our securities to our customers we have brought about real public ownership as distinguished from political ownership, and retained all the advantages common to private enterprise. The National Electric Light Association has hundreds of committees, comprising thousands of experts, at work on the problems of the electric light and power industry. These men contribute freely of their experience and time with one definite object in view—perfecting and lessening the cost of electric service. No one company could command or afford such an array of talent, and competition between electricity supply companies being a thing of the past, it is evident that the deliberations of these experts are as frank as they are constructive. I know of no other industry where such interchange of experience and knowledge is so wholehearted and complete, and which privately-owned manifests so much solicitation and concern over the public weal.

In all but two of the States of the Union, the electricity supply undertakings are subject to regulation by State public service commissions, which exercise supervision over the service, the rates charged therefor, and in many instances the money invested therein. The electricity supply companies being granted a monopoly in their respective territories, regulation follows, of course, as a natural result. With possibly a dozen exceptions, there is but one electricity undertaking in every large community, and it is not unusual to find one company supplying the needs of hundreds of communities.

We have had in the States for many years so-called super-power stations, and in the interests of economy and reliability the vast networks fed from these super-power stations have been interconnected. The combined area of England, Scotland, and Wales is approximately 88,000 miles; the area of California exceeds 158,000 square miles. In that State there is an interconnected transmission network extending from Oregon, on the north, to Mexico on the south, traversing the entire State. In the South-eastern section of the Atlantic seaboard there is also a vast interconnected network extending from North Carolina into South Carolina, Georgia, Alabama, and Tennessee, involving the systems of over half-a-dozen electricity supply companies, which are thereby enabled to interchange electrical energy to the mutual advantage of themselves and the communities they serve.

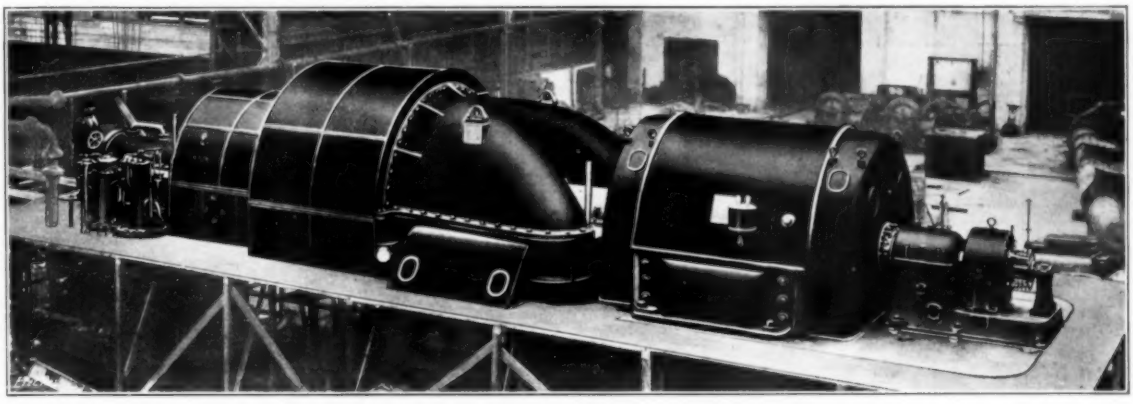
Generating stations in the States are naturally large and efficient, making use of every labour-saving device known in the mechanical arts. Some generating stations are to be found with ratings as high as 400,000 kW, with single-cylinder turbo-generating sets rated at 62,500 kVA, and compound turbo-generating sets rated as high as 75,000 kVA. In these mammoth stations a kilowatt hour of electrical energy is produced from less than one and one-half pounds of coal, and due to the size and character of the units the saving in labour is considerable.

In recent years financial considerations have grown so important as to largely subordinate problems of engineering. Notwithstanding the enormous expansion of the electric light and power industry in the United States, where for the past twenty years it has maintained unbroken a record of doubling its output every five years, the industry could acquire still larger loads if it could obtain readily and cheaply the necessary funds to take care of the business. Thus, the financial problems are of paramount importance.

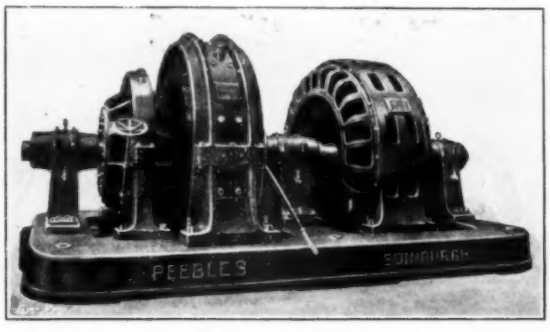
Briefly, the foregoing seem to the writer to be the outstanding features and the impelling motives of the electricity supply companies of the United States. There is a much greater difference between electricity supply practices in America and England than is generally supposed, but the writer has attempted to restrict his observations to American practice, leaving it to the Britons to make whatever application they may wish. Happily, a cordial friendship has always existed between American and British engineers, and this will no doubt long continue. We in America are conscious of the fact, however, that what is possible in one country may not be possible in another, due to different social and political conditions. There is no doubt that each can learn much from the other, but whatever changes are made in the future must necessarily conform to the habits and traditions of our respective peoples.

SOME BRITISH MANUFACTURES.

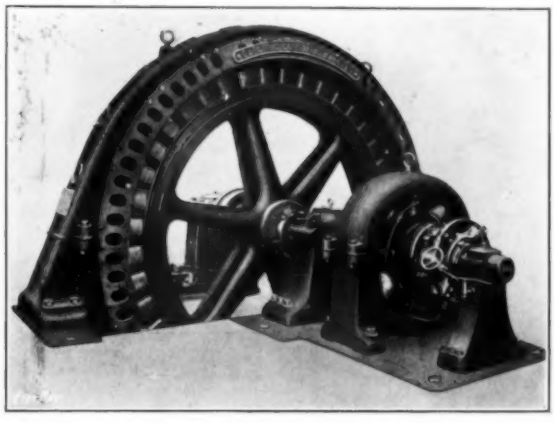
The changes which have taken place during the past half-century have been so vast, and embrace so many factors wholly unknown and unimagined in 1872, that to institute comparisons between the state of the art then and now would be futile. Doubtless the advances that will be made during the next half century would be no less startling, could we but see them; that privilege will be denied to most of us, but at least we may place on record some examples of British manufacturers' achievements, which our successors, fifty years hence, may perhaps think it worth while to reproduce in contrast to the practice of that far-off day. The collection will serve also to indicate in some small measure the versatility and capacity of British manufacturers, who are now prepared to cope with any conceivable demand for electrical materials and apparatus. Admittedly, it makes no pretensions to completeness in respect of either the products illustrated or the makers represented; to attain that end would require not four pages but a thousand. The collection therefore has been limited to a few typical examples of plant, such as in some cases are obtainable from several sources in this country.



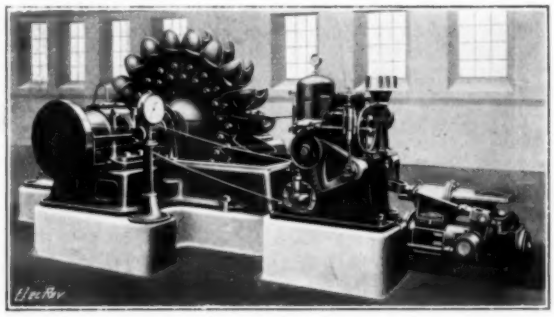
Turbo-generator.—Parsons reaction turbine, designed for steam at 180 lb. pressure superheated to 572° F., and for an exhaust vacuum of 28½ in. Direct coupled to Parsons 3-phase alternator (50 cycles, 6,600 volts); economical and continuous maximum rating, 20,000 kW at 1,500 r.p.m., 0.80 power factor. Constructed for the Shanghai Municipal Council, China, and shipped (with alternator completely wound) this year, by Messrs. C. A. Parsons & Co., Ltd.



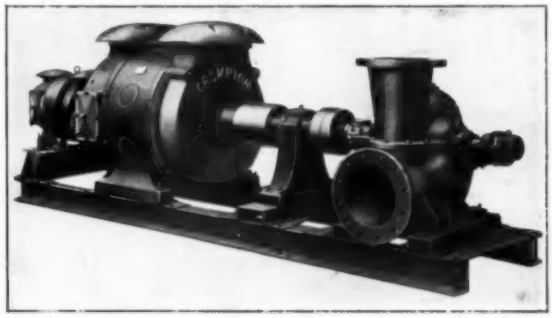
Motor-converter.—Built for Sydney by Messrs. Bruce Peebles & Co., Ltd., converting a.c. to d.c.; rated at 2,000 kW.



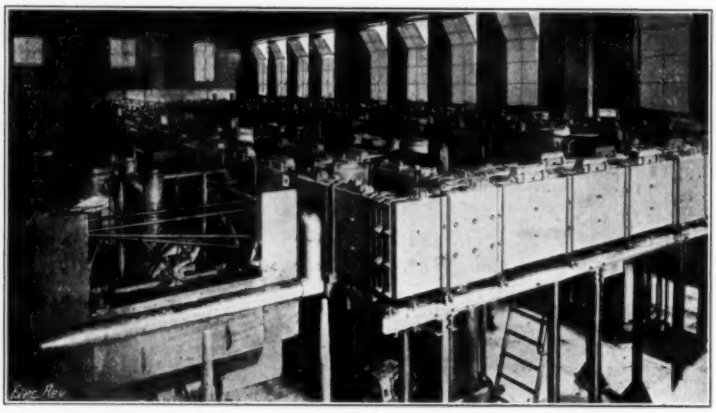
Alternator.—Three-phase alternator and exciter, built by the Electric Construction Co., Ltd., for direct coupling to a Diesel engine.



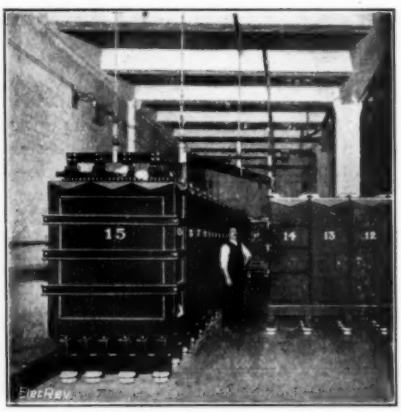
Pelton Wheel.—Installed at the British Aluminium Co.'s works, Kinlochleven, by Messrs. James Gordon & Co., Ltd. Head, 890 ft.; speed, 300 r.p.m.; wheel diameter, 81 in.; jet, 5 5/16 in. The largest turbine in Great Britain.



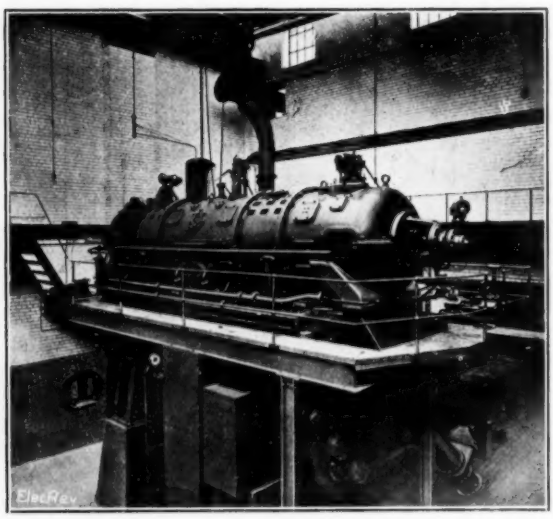
Mine Pump.—A 400-V, 100-kVA, 3-phase, 50-cycle, 750-r.p.m. motor and pump, raising 3,000 gals./min. 40 ft., built by Messrs. Crompton & Co., Ltd. Induction synchronous motor, specially arranged to raise power factor of circuit from 0.7 to 0.9.



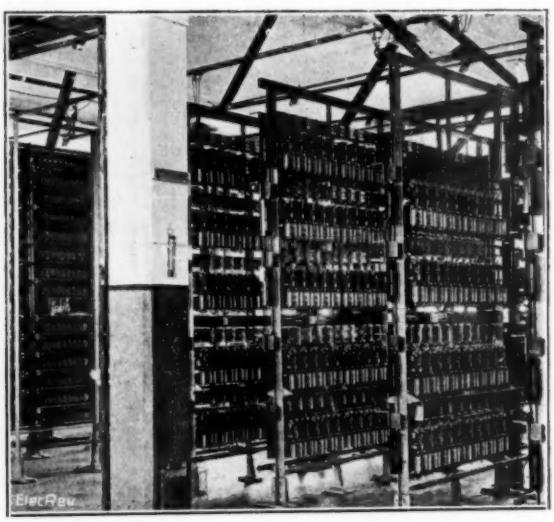
Ironclad Switchgear.—Switch-room at the Dalmarnock electricity works of Glasgow Corporation, equipped with ironclad switchgear by Messrs. Reyrolle, Ltd.; 20,000 V; rupturing capacity of each switch 1,500,000 kVA; remote control.



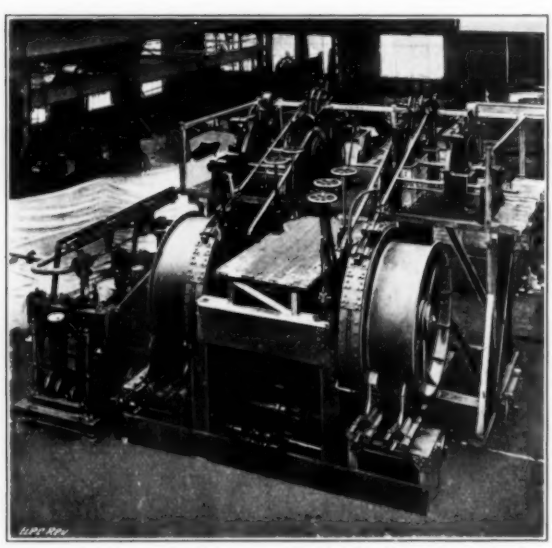
Storage Battery.—Installed at Eagle Street sub-station, London, by the Chloride Electrical Storage Co. Each cell weighs 2¼ tons and gives 8,000 A for 35 minutes; capacity, 12,000 Ah.



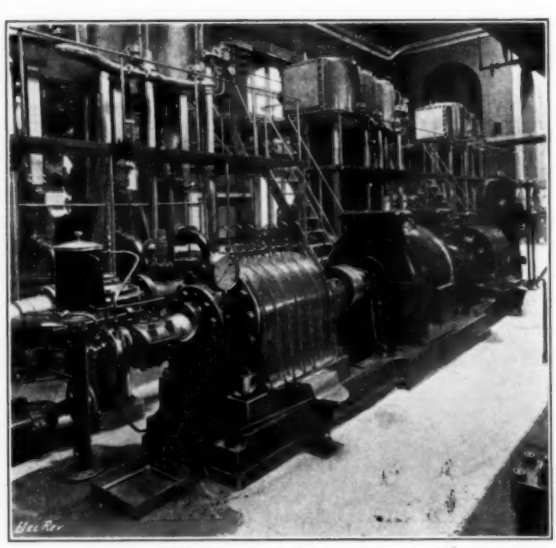
Turbo-generator.—A 3,000-kW, 3,000 r.p.m. Brush-Ljungström set installed at Ipswich Corporation Electricity Works, by the Brush Electrical Engineering Co., Ltd.



Automatic Telephone Exchange.—Part of a 6,000-line full automatic exchange supplied to Winnipeg, by Messrs. Siemens Brothers & Co., Ltd.—the first large automatic exchange exported from England to Canada.

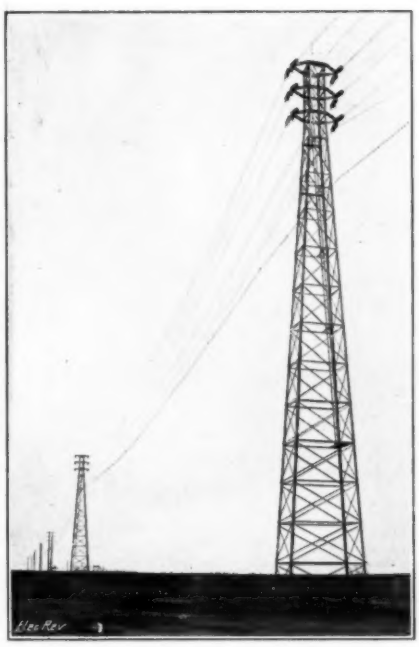


Cable-steamer Equipment.—One of two submarine cable-laying gears supplied to the Great Northern Telegraph Co., Ltd., by Messrs. Johnson & Phillips, Ltd.: double engines of 220 b.h.p., hauling 25 tons.

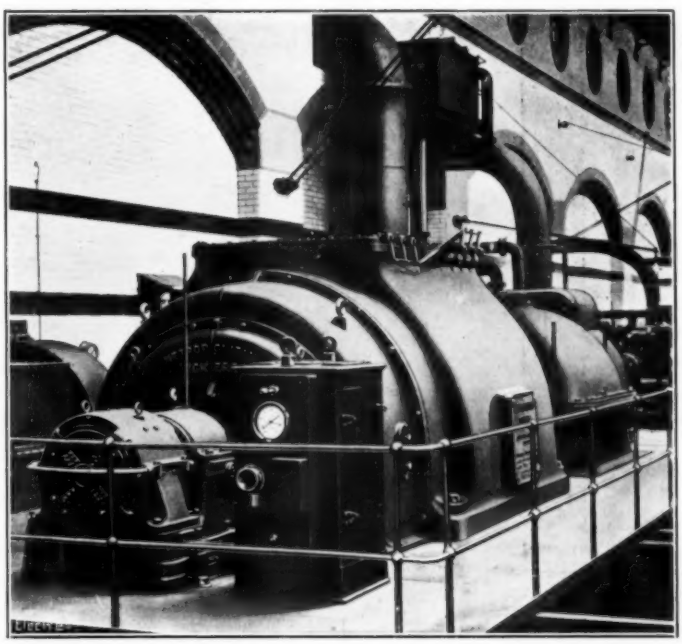


Hydraulic Pumps.—One of three sets of pumps supplied to the London Hydraulic Power Co., by Messrs. Mather & Platt, Ltd. Duty 500 gals./min. at 800 lb./sq. in. Motor of 440 b.h.p., 6,600 V, 3-phase, 50 cycles.

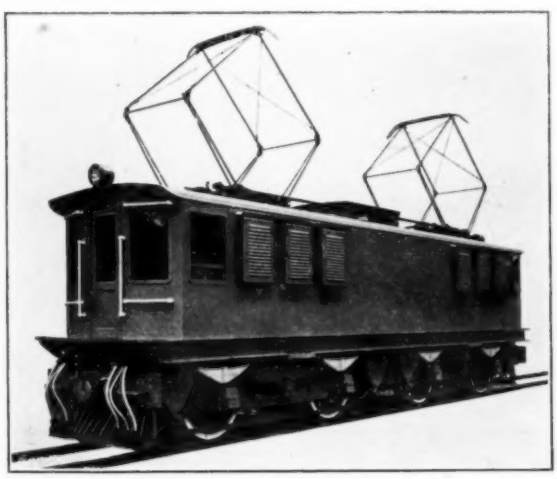
Telephone Exchange.—Switch-room at the Clerkenwell Post Office Telephone Exchange, London, equipped throughout by the Peel-Conner Telephone Works (proprietors, the General Electric Co., Ltd.). Ultimate capacity, 10,000 lines.



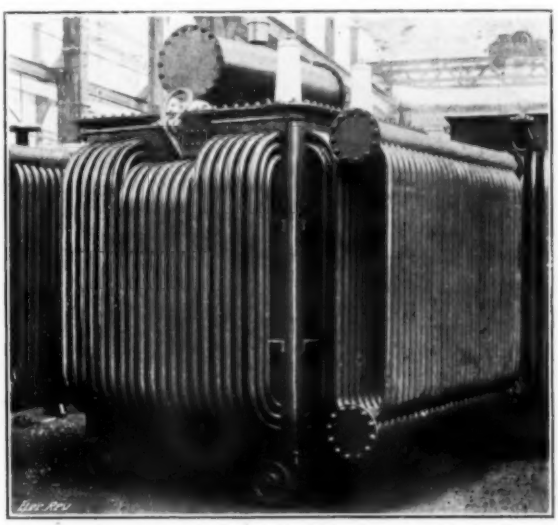
Overhead Line.—Crossing the River Blyth, Northumberland, on steel towers 106 ft. high. Two three-phase circuits, 20,000 V, 40 cycles, 0.1 sq. in. conductors. Installed by the British Insulated & Helsby Cables, Ltd.



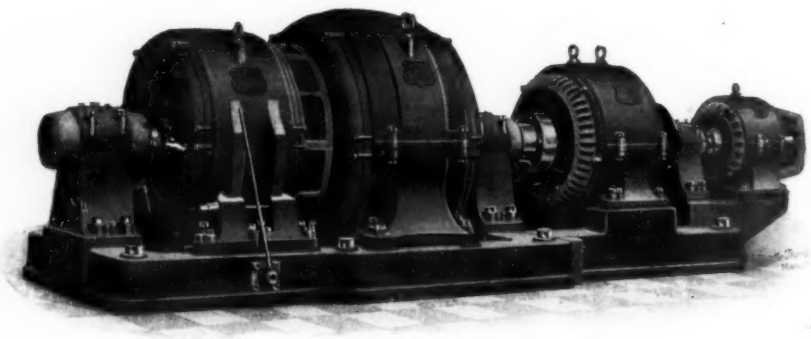
Turbo-generator.—A 12,500-kW, 3,000-r.p.m. set supplied by the Metropolitan-Vickers Electrical Co., Ltd., to Liverpool Corporation; fitted with Baumann's multiple exhaust, which reduces diameter of disks and peripheral speed 25 per cent., whilst allowing the output obtainable from a single cylinder to be quadrupled.



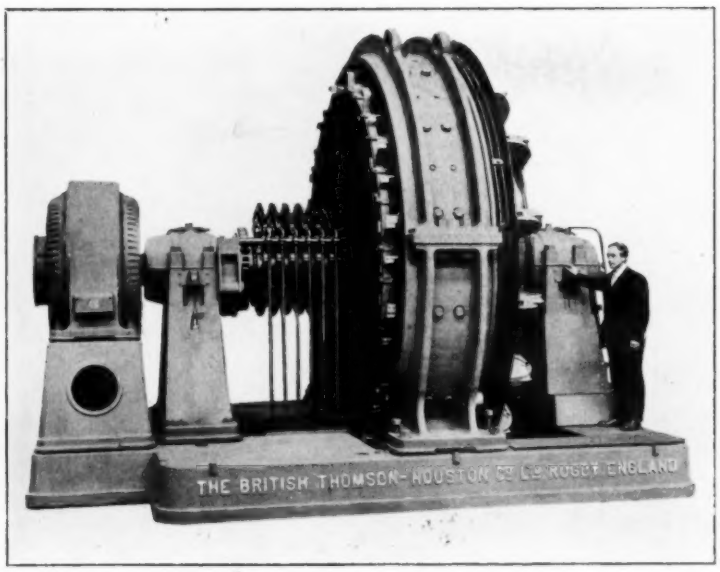
Electric Locomotive.—Built for the Midland Railway of New Zealand by the English Electric Co., Ltd.; equipped with four 1,500-V, 170-h.p., d.c. motors.



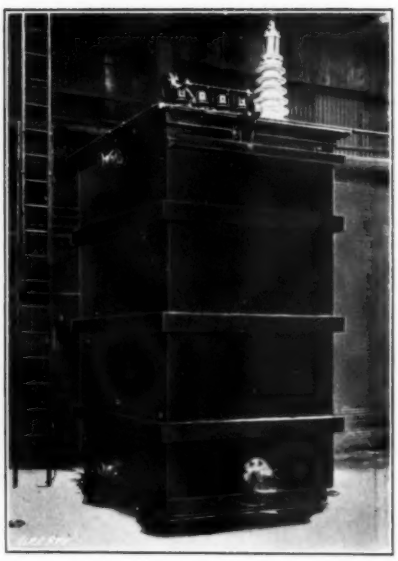
Transformer.—One of four 3,333-kVA, 50-cycle, self-cooled transformers being supplied to Barcelona by the British Electric Transformer Co., Ltd.



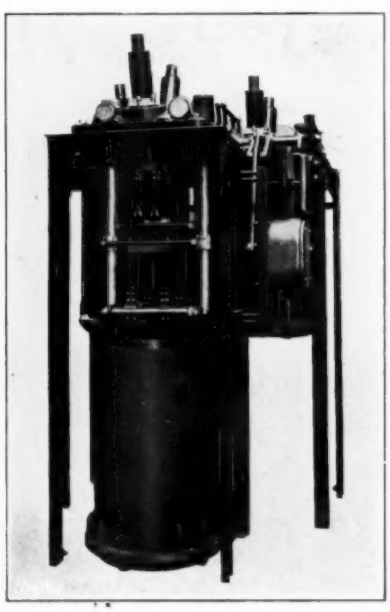
Frequency - changer. — One of two 600-kVA sets supplied to the City of Guelph, Canada, by the Lancashire Dynamo and Motor Co., Ltd. Each set comprises a "Lancashire" self - starting synchronous motor coupled to an alternator (with rocking stator), a d.c. traction generator, and an exciter.



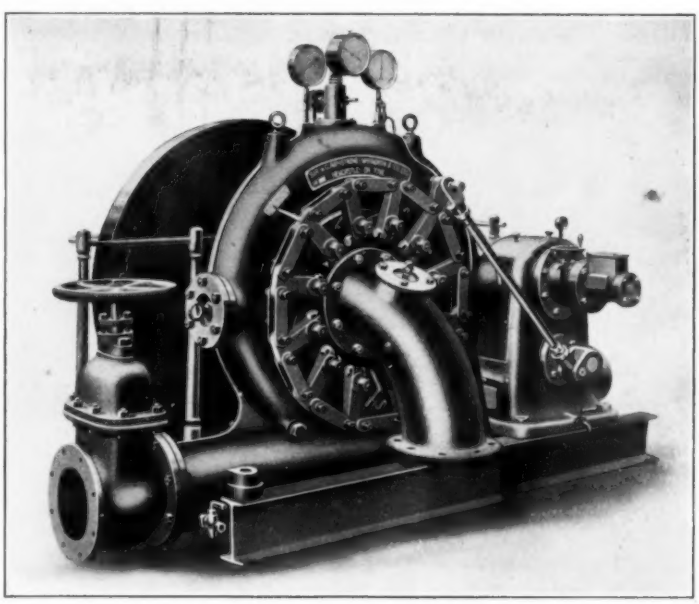
Rotary Converter.—One of four 25-cycle, 4,500-kW machines supplied to the Victorian Railway Commissioners, Melbourne, by the British Thomson-Houston Co., Ltd., for heavy traction service; 1,500 V, 3,000 A, 187.5 r.p.m.; 9,000 kW for one minute. Started up with self-synchronising induction motor and connected to d.c. bars within 1½ minutes. Largest built in Great Britain.



Transformer.—One of seven 4,000-kVA transformers for a 110,000-V, three-phase transmission system, Mangahao, New Zealand, built by Messrs. Ferranti, Ltd. Weight, 21¼ tons.



Circuit-breaker.—Built for Manchester Corporation for group feeder control, by Messrs. Ferguson, Pailin, Ltd. Rupturing capacity. 1,000,000 kVA; 2,000 A, 33,000 V, 3-phase; each pole in separate steel tank.



Turbine.—One of two sets supplied for Dorrigo, New South Wales, by Messrs. Armstrong, Whitworth & Co., Ltd.; spiral type.

SUBMARINE TELEGRAPHY.

By Commander ROLLO APPLEYARD, R.N.V.R., C.B.E., J.P., M.Inst.C.E.

"The mighty future is as nothing, being everything; the past is everything, being nothing."

From time immemorial the accepted method of celebrating anniversaries has been to recall the scattered incidents relating to the theme, and to string them into a story for the instruction or amusement of those who will listen. In the ordinary course of events this method would have been adopted to proclaim the present jubilee. It would have indicated how a periodical which started on its famous career on November 15, 1872, pursued its way for half a century, ever with a hand to help and a voice to cheer those who laboured truly to establish the electrical industry. With characteristic delicacy, however, the Editors have abandoned for this occasion the historical plan; they desire that the world shall be reminded that the electrical industry has not yet lost, and must never lose, the youthful spirit that is its heritage. Here, then, though our thoughts may occasionally turn to the work of the telegraph engineers and electricians who were the pioneers, let us not speak too much of years.

"They have wakened the timeless Things; they have killed their father Time;
Joining hands in the gloom, a league from the last of the sun.
Hush! Men talk to-day o'er the waste of the ultimate slime,
And a new Word runs between: whispering,
'Let us be one.'"

Bygones shall, so far as possible, be bygones, dismissed with the knowledge that the history of applied science, and indeed of applied art, has no page more brilliant or enchanting than that upon which is recorded the birth, the growth, and the achievements of submarine telegraphy.

Photo by] [J. C. Beresford.

Rollo Appleyard.

It must be confessed that, in contemplating submarine telegraphy, it is easier to pass in review from what *was* to what *is*, than to travel in anticipation from what *is* to what *will be*. In either case, however, the transition leads and has led the investigator step by step, effort by effort, through that fascinating region of research, partly physical, partly mental, that broadens out from the sunset-edge of things accomplished, and extends from what is known to what did or will happen. Submarine telegraphy illustrates, moreover, that the one demand held by natural science against the investigator, within this region of discovery and invention, is that he shall watch and measure and refuse to drift. To advance, he must try to take his bearings and to ascertain his distances, even though his rods and clocks conspire with the ether to delude him. Above all, upon the plane of what is reasonable, possible, or probable, he must ever appeal to experiment. If the experiment is made and studied, though it may seem to fail, the endeavour itself disturbs contact with what is known, and simultaneously from the world of the unthought-of a new notion springs into existence and flashes across the gap of ignorance to be recognised as an increment to knowledge.

In submarine telegraphy there is no evidence that we are approaching the limit of what can be accomplished by observation, measurement, and experiment. Nevertheless, although materials and phenomena associated with the subject are particularly appropriate for research of that character, and although theory is well advanced, the process of development, so far as appertains to the cable in actual use, is remarkably slow, both as regards design and construction. Attention is frequently directed to new principles applied to telegraph instruments, to improved methods of signalling, and to the threat of the supersession of cable-telegraphy by some other form of message-transmission, but why is there so little change in the accepted design of the cable itself? The explanation must be sought in the fact that mechanical, as well as electrical, requirements have to be fulfilled, and that the existing form of cable is comparatively satisfactory in both respects at the price. Any modification of design that entails increased cost has a hard struggle for acceptance, unless it can be proved to bring about either increased durability or increased efficiency of transmission. Future designers will study this problem not merely by seeking to develop the conductor, the dielectric, and the mechanical protection of the cable, but also by endeavouring to proportion the inductance and leakance so as to secure rapid and well-defined signals. A prophet might hazard the opinion that their success will depend upon their chemists as well as upon their mechanicians.

So far as the conductor is concerned, the conclusion arrived at by Matthiessen that pure copper had higher conductivity than any of its alloys deprived future research students of many happy days of investigation. On the other hand, it directed the efforts of copper-wire manufacturers to the need for purity, and as they have already been successful, much further progress along this line is difficult to imagine. The chaos of the coinage, and the creation of paper money, may be followed by such a deluge of silver that the metal market may suffer a complete change. The best that could happen would be that pure silver should thereby fall in relative value so as to be comparable in price with copper. From such a substitution, an improvement of about 5 per cent. in the speed of transmission through cables might be expected to arise, and the increased revenue resulting therefrom is perhaps the only shred of hope for the recovery, on balance, of some of the world's losses.

Next in importance to purity is care in annealing the wire for the conductor. Wire-makers have vied with one another to obtain the softest product, and although finality may not have been reached, they have left the research student a giant's task to produce a better result. It is to be observed, however, that although

the copper wire is carefully annealed before it enters the stranding machine, there is always the chance that it may be subjected to stresses during the stranding process. If, in the future, the design of the machine were so far improved as to remove these stresses, the corresponding gain in transmission might be of the order of one-half per cent., but it would scarcely be greater.

An astute observer, examining the stranding machine in quest of possible developments, might carry out a research upon the sticky compound that unites the centre wire to the outer wires of the strand. By filling up interstices, this compound renders the strand more or less free from air-cavities, which would be disadvantageous in subsequent operations. As the compound is of the nature of a dielectric rather than a conductor, it obviously would be more useful outside than inside the strand, provided that a conducting substance could be devised as a substitute to eliminate air. The proportion of compound within the strand varies considerably in different strands, but in some instances it is a substantial amount, attaining, perhaps, 1 or 2 per cent. of the weight of the copper. This astute observer will at once suggest that the strand should be passed through a bath of molten solder, or other metal, instead of compound, and then through a die to secure a smooth metallic surface and a circular section. Unfortunately this operation would deprive the strand of its flexibility, and it would add materially to the cost. The experiment would, however, have the useful effect of causing renewed inquiry to be made into the merits and demerits of replacing the strand by a single solid copper wire of circular section.

It is recognised that a solid wire would have decided advantages. An approach to such a conductor has been obtained by lapping copper tapes round a central wire. As compared with a strand of normal design, a certain degree of flexibility is thus lost, and the copper of the tapes is probably more severely stressed than is that of the ordinary outer wires in a normal strand during the operation of stranding. This form of conductor is a suggestive, though imperfect, step towards a design giving the lowest electrostatic capacity and the least electrical resistance for given weights of copper and dielectric.

In addition to the advantage of flexibility, a stranded conductor has the merit that, in the event of the disruption of one of the component wires of the strand, the others may be expected to maintain continuity. It might, of course, be argued that a single wire of seven times the tensile strength would be less liable to disruption. Further, with currents of high frequency, the distribution is likely to be more uniform over the section in the case of a strand than in the case of a solid conductor; but for telegraphic currents, from the electrical standpoint, the single wire would probably have preference, because of the reduction in diameter of the conductor as a whole as compared with a strand of the same material of equal resistance, and the consequent diminution of electrostatic capacity. Future electricians will be trained to calculate these relative merits and demerits to a nicety, and if they decide that a single wire of circular section would be electrically as good as, or better than, a strand of equal weight, and not inferior mechanically, they will call upon the mechanicians of their day to dispose of the difficulty of increased rigidity. They will discover, incidentally, that the rigidity lurks not only in the conductor, but in the specification, and that it is easier to remove it from the one than from the other.

Those who have struggled with difficulties of this character will find entertainment in contemplating what awaits those who are to carry on the work. It can be truly said that if the surmounting of these electrical and mechanical obstacles gives to future workers as much satisfaction as it gave to the pioneers of our day, the newcomers will be happy labourers in a field of surpassing fascination. As we are here upon ground that is entirely hypothetical, let it be supposed that the newcomers decide in favour of a single-wire conductor. Developments would probably take the form of improved means for straightening and annealing the wire before covering it with dielectric; for large wire with bends in it would lead to a decentralised core, and would be intolerable. With such a conductor, special arrangements would be necessary during the covering process to ensure that the dielectric forms a symmetrical coating sufficiently firm to enable the core to be wound upon the machine-drums without deformation of section. At this stage the electrician will in fact begin to worry the mechanician for a core with a "good centre," and it is probably at about this time that the mechanician will seek assistance from the chemist. If they succeed, an advance will be made towards efficiency and economy.

The time-honoured method of applying the dielectric in three separate coats, with compound between each, has already been departed from on several occasions, and ingenious machinery has been devised for reducing the process to a single operation. This suggests that, in the future, it may be possible to reduce the amount of compound between the coats, or even to eliminate it, so as to have the advantage of a homogeneous covering of the best material for the purpose of transmission and durability. Here, again, however, there will be objections to any change in the specification.

From whatever aspect an attempt may be made to develop the submarine cable, the inventor, the economist, and the electrician will meet at a point, and that point will always be the joint in the core. Any modification of the conductor, dielectric, or sheathing that imperils a joint must be rejected. Now, the jointer is of all men the most conservative and the most despotic; of applied science, art, and industry he is the consummation. Nevertheless, a wise captain will not allow him to control the cable-ship, and a prudent manufacturer will not allow him to oppose all developments. He has to be told that the dielectric of yesterday is not the dielectric of to-day. His skill, however, is considerable, and it will enable him to modify his procedure, if necessary, to meet the requirements of the future. With each change of design or dielectric a set of experimental joints must be made and tested.

A change in the material used for the dielectric of submarine cables is, to many of us, difficult to contemplate. Does not every text-book tell us that it is gutta-percha? Closer acquaintance with the subject, however, introduces us to a number of varieties of the gum, the choice products of Pahang, Johore, Bulongan, Sarawak, Bagan, Sarapong, or Macassar; and experience tells us that each variety is subject to surprising divergences of quality. The truth is that time and avarice have degraded the old market. One important result has been that balata from Venezuela has competed against the products of Singapore with considerable success. A further consequence has been that the process of deresinification has been developed, and that the resulting dielectric has very favourable characteristics, especially with regard to electrostatic capacity. The manufacturer to-day has thus considerable latitude, and the prospect of further development is as hopeful as it is enticing. During the next half-century it may confidently be expected that still lower electrostatic capacities will be obtained, and that this will constitute one of the most direct lines to improvement in core construction. Chemistry will seek new victories, but the jointer will continue to decide the issue.

The total effect of modifying the material and cross-section of the conductor, and of carrying out an extended research on the dielectric, might be to improve transmission to the extent of, say, 25 per cent. in fifty years. This would be a fine achievement, but the pace would be far too slow to satisfy the research student. Let him therefore begin with the core as it is, and press on with the development of a new type. The first step will be to extend his measurements. Inductance and leakance must be determined for his core, as well as its resistance and capacity, for a range of frequencies, and

his task will be to proportion these four quantities to produce the best effect. He will probably be obliged to introduce inductance into the core, either as a continuous lapping of iron wire over the conductor or as a series of separate "loading" coils, in which respect submarine telephony has already outstripped telegraphy. And to these four quantities he must add four others: the cost, the joint, the specification, and the durability.

The addition of inductance will demand close attention to the question of durability. The gutta-percha in the core of a submarine cable requires to possess a certain amount of moisture to prevent rapid deterioration, and this amount may vary from about 1 to 3 per cent. A lapping of very thin iron wire over the conductor might, for protective and electrical reasons, need to be treated with some kind of varnish. This would increase the cost; and the varnished metal may be less effective than plain iron wire, because of the space taken up by the varnish.

Attention has here been directed to the cable itself rather than to instruments or to methods of transmission. Several considerations lead to the belief that study of the cable is the most helpful line of approach to the future. Fortunately, the barrier of conjecture that stood in the way of research in this direction has to a great extent been removed by devoted work in the realms of theory by men whose labours will be more appreciated in the next fifty years than they have yet been. It is denied to us to-day to retrace our steps or to recall the names of those who have performed this service; we are pledged to look forward, and it must suffice to record that recent work by mathematicians has reduced the complex theory of submarine telegraphy to practical arithmetic, thus leaving the field of investigation free to be dealt with in the laboratory and at the cable-station.

Success will depend upon applying the improved apparatus of the present and the future, to overcome the inherent limitations of design and construction of the cable. The first limitation seriously affecting the addition of inductance is that a submarine telegraph cable has but one insulated conductor. A telephone cable has two. Again, in telephony it is possible roughly to average the frequency of the vibrations corresponding to speech; but in telegraphy, which employs a more or less broken sequence of transient and irregular impulses, it is hardly safe yet to assume a definite mean frequency. In submarine telegraphy, therefore, resonance is elusive. As we cannot tune our harps we must console ourselves with the drums. Nevertheless, it is reasonable to suppose that in another decade or two, from the transmitting, receiving, relaying, rectifying, magnifying, and translating apparatus of to-day, including the wondrous thermionic valve in a developed form, will be evolved a comparatively simple system of signalling through telegraph cables which, in combination with a developed type of core, will lend itself to the conditions necessary for an approach to the distortionless circuit. The moment, in fact, appears to be fast approaching when the cable will be designed and constructed more nearly as a component of the apparatus —as the arrow to the bow.

In view of the multiplicity of conditions that determine the life of a submarine cable, as it enters the ocean and chafes on the shore over merciless tide-swept rocks, or as it gropes its way along the ribs of the earth towards the quiet ooze, miles deep, and creeps slowly up the treacherous slopes into the fish-haunts where trawlers grapple, or finally, as it regains the shallower levels where anchors threaten to claw its sides, the endeavour to predict what the future may reveal in the development of sheathing, laying, and picking-up, is in vain. All that need be said about it is that, thanks to the ingenuity and virility of our race, these problems are, for the purposes of the immediate future, sufficiently solved. The chances are that the operations will remain substantially unaltered for the remainder of the century. Let us therefore use every effort to ensure that in this respect what Great Britain has won, Great Britain shall hold.

THE PRESENT AND FUTURE OF POWER-STATION EFFICIENCY.

By W. M. SELVEY, Wh.Sc., M.I.E.E.

All engineers will join in the congratulations due to the Electrical Review on the occasion of its Jubilee. The progress made during this period, in which the Review has held its familiar position in the ranks of the now great electrical industry, has been described in a fascinating manner in the Jubilee number of the *Journal* of the Institution of Electrical Engineers.

It is perhaps interesting, and perchance it may be profitable to review the present, and grope vaguely into the future. We may be quite certain that to have reversed the process, as did H. G. Wells in his "Time Machine," and to have announced to the people, the educated people, of fifty years ago what are now commonplaces of electricity, would have been to evoke howls of derision or accusations of insanity.

Any real vision of the future is therefore likely to receive the same fate to-day, unless it should seem so utterly fantastic as to be treated as good fiction, when it might achieve the worse fate of becoming a "best seller."

The scientific world has recently been exercised with the physiological matter in the address of the President of the British Association, Sir Charles Sherrington, at Hull. There is an analogy between the way in which the "nerve" conductors grow outwards from the brain, and the way in which our power stations are stretching out their feeders. A survey of the present shows that the more advanced in efficiency the power station becomes, the farther does it stretch out. It is a cumulative process. The stretching-out is at first an expense and a loss, but when the firm attachment is made, then the feeder becomes a means of sending back an encouragement, a fresh power to the brain, which enables it to improve its efficiency, to grow, and then to send out fresh feeders; these in turn again strengthening the brain centre.

Having evolved the complete organism, in the case of the human being, the brain then acquires the power of joining and acting with, for mutual help and encouragement, other similar organisms. So also our advanced power station is the first to come into contact with other power stations, and a similar effect is produced.

Ultimately we arrive at the political body, the State, and so may we imagine in the future, the physical connection of all stations, separated by that interval of distance which best suits the necessities of the areas they serve.

Similarly, as in human life, the more advanced stations will act as mentors and leaders to the smaller stations in the system, and ultimately a balance will be attained between mere size and average convenience. This process is already slowly going on, and will be accelerated only when the Force residing in Help and Example is fully felt in the completely joined-up "National System."

Comparing the more advanced with the less is to realise that without any radical departure in efficiency, the raising of all to an equally strong position would make just the difference shown between the possibilities of the caveman and the power of the organised nation.

Electricity is still severely competing with "isolated

combustion" in every walk of life, and has perhaps only attained 15 per cent. of its possibilities to-day. While the isolated and small power station has a heavy task to compete with the isolated steam plant, yet it is doing it slowly; on the other hand, the most advanced power station has a heavy task to compete with the large efficient isolated plant. Yet both are winning, and when the large station takes over the burden of the small station, in the very giving of help, it receives fresh power to deal with its own competitors. Let us examine just a little the difference between the large and the small.

The figures for high-pressure steam generated and interheated have been given in the writer's address to the North-Midland Centre of the Institution of Electrical Engineers. It is not necessary to refer in detail to the figures and diagrams there given, but they do show that a diagram efficiency of 40 per cent. is possible.

Boiler efficiency we know under steady conditions can now be maintained at 85 per cent. Turbine efficiency is still improving, and the writer sees no reason to change the opinion given in Merz and McLellan's paper so long ago as 1904 that ultimately 85 per cent. will be obtained. Then there is the margin for station use, operation and machine load factor losses to allow for, which for steady loads may be as low as 7 per cent., and need not be higher than 15 per cent. in any case in the future for a large station.

These factors multiplied together give 0.40 × 0.85 × 0.85 × 0.85 = 24.57 per cent., which is the prospective figure announced by Mr. Ferranti at Ilkley (I.M.E.A. Convention, 1920).

We are much in need of a "standard" coal, and it would clarify discussion much if each figure quoted of "pounds of coal per unit" were given in terms of standard fuel. The fuel is at present bad compared with what it might be if all collieries washed their coal, but if we take "11,500 B.th.u. per lb. as fired" as standard coal, then the efficiency of 24.5 per cent. will be equivalent to a heat consumption of 13,930 B.th.u. per unit and a coal consumption of 1,21 lb. per unit, giving with coal at £1 per ton a coal cost per unit at the station of 0.13d.

Now if a study is made of the *Electrical Times* records and a rough curve plotted between the output and the "coal costs," it is easy to see how undertakings with low costs have been in increasing measure enabled to collect business. It does not require much prevision to see how the snowball effect will operate as large stations grow all over the country. And they will grow, in spite of many obstacles, "fightings within and fears without." The sort of economic pressure outlined will act, if with glacier-like slowness, also with equal certainty.

Each large station, by the effort of its establishment, will draw strength to itself, and everywhere around us the start is being made. Manchester, Birmingham, Sheffield, Rotherham, Blackburn, Glasgow, Edinburgh, Leicester, as well as the North-East Coast Companies from which the text of the parable was taken, have developments of a size and character calculated in time to draw the line of the comparative level at a higher altitude.

Another and striking aspect of the present, and one which is full of hope for the future, is the way in which the smaller stations and their organs of plant are rapidly improving in efficiency, small sets coming within 20 per cent. of the efficiency of the largest sets. This is especially apparent in isolated industrial districts like Lincoln and Peterborough and Luton, where it must be some years before complete articulation with the main system can occur. Each such case strengthens the industry as a whole, and assists materially in another direction, on which much could be written, namely, that of mass production of cheap and reliable apparatus.

In the foregoing it has been argued that the highest efficiency in sight for a large power station worked at a high load factor is about 24.5 per cent., and that if this efficiency were equally obtainable at many of the principal centres in the country, many of the desires of electrical engineers would be realised. It has also been pointed out that the force of example has led the smaller centres to expect and attain efficiencies which come wonderfully close to the larger schemes. These matters are probably worth a little closer examination.

Let us briefly consider first the problem of the steam cycle used.

Photo by] [Simpson's Studios.

W. M. Selvey.

As far as our knowledge goes at present, it does not appear that high pressure alone presents any striking difficulties, the limitations are still in the direction of temperature.

The small and middle size concerns which are typified in many minds by having generating sets, say, of 3,000 kW and 6,000 kW capacity, may now be associated with 265-lb. and 350-lb. pressure, and in favourable cases with 28.5 in. and 29.1 in. vacuum, and with 688° F. total temperature.

The cycle efficiencies in these cases are 33.9 per cent. and 36.4 per cent. The various organs cannot, of course, realise such high efficiencies as in the largest concerns, and it is doubtful whether anything but the ordinary steam cycle should be attempted (except in one particular, which will be referred to later). It would be possible to-day to obtain turbine sets of these sizes with efficiencies of 70 per cent. and 73 per cent. at the alternator terminals were it demanded.

The boiler would naturally be a smaller unit, and the steady efficiencies obtainable may be put at 78 per cent. and 81 per cent. for the corresponding sizes. The remaining figure for the general losses must be put at a higher value than before, because the smaller concern can seldom command the load factor and such-like favourable conditions, but it may be fairly taken as 25 per cent. and 20 per cent. respectively.

Thus we arrive at two general conditions of—

The smaller concern using 3,000-kW sets,

$$0.34 \times 0.70 \times 0.78 \times 0.75 = 13.9 \text{ per cent.,}$$

and the moderate-size concern using 6,000-kW sets,

$$0.36 \times 0.73 \times 0.81 \times 0.80 = 17.0 \text{ per cent.}$$

These are not figures realised to-day, but ones which might be realised for a new plant designed to-day under favourable conditions where sets of such size seem to be of the right capacity for the load in sight for the next decade, and which are therefore isolated from large industrial centres.

Translating them into terms of the suggested

"standard coal" of 11,500 B.th.u., they signify coal consumption of 2.14 and 1.75 lb. per unit, and with coal at £1 per ton, coal costs of 0.23d. and 0.188d.

In order to avoid any misunderstanding by the reader who reads rapidly, it is necessary to emphasise that these are not figures to be expected from every station that already has sets of a size such as we are considering. They are figures representing possibilities in the future for plants designed to take the fullest advantage of the experience gained with the plant of maximum size. The note to be struck is one of hopefulness for those engineers who feel that they have only a moderate-sized cake to bite at. There may be many such who have a decade of uphill work before them, without any hope of sharing the larger developments except in the way indicated.

One more matter may be mentioned about the cycle. Workers on the theoretical problem of air as a working fluid for use in a gas turbine are well aware that only by very complete regeneration can they hope to approach the efficiency of the "Carnot cycle." The temperature-entropy diagram for steam is well known.*

It is quite obvious, from a consideration of that diagram, that the higher the pressure of and therefore temperature of evaporation, and consequently the lower the degree of superheat, the nearer the centre part of the diagram approaches the Carnot cycle, the less important is the region to the right, and the more important the region to the left. If the heat supplied to the water can in any degree be obtained regeneratively by the heat rejected from the steam, then, although the Carnot cycle is not followed, the Carnot efficiency is approached. As long as all the heat of the middle portion is rejected at the lowest temperature, then regeneration is impossible, but if a small portion is rejected not at t_{vacuum}, but $t + \Delta t$, then this can be used to regenerate the water from t to $t + \Delta t$. Then, if a further small portion is rejected at $t + 2 \Delta t$, this can also be used to regenerate the water further. Theoretically, if this is done in an infinite number of stages with complete efficiency, not the Carnot cycle, but the Carnot efficiency, is approached.

Such a scheme has been effectively applied for one stage on a well-known make of turbine, and can be carried several stages further by what are known as successive "bleedings," a horrible "Americanese," which, however, hits the mark. Three stages are involved in the latest projects.

There is, however, another practical consideration. Much of the heat at present used in the left-hand part of the diagram is supplied by the gases leaving the boiler, and as the pressure rises this heat increases.

To throw it away would nullify the profit of the regeneration, and the only course open is to again adopt the regenerative system and return it to the air used for combustion. Although a moderate amount of air heating of from 100° F. to 130° F. (*i.e.*, about 3 per cent. of the total heat) is probably quite feasible on the usual machine stoker, it becomes a grave question whether 10 to 15 per cent. of the total heat can be thus dealt with unless by some radical departure, such as the use of powdered fuel. This suggests, however, a line of progress which, no doubt, has received the most careful consideration by those responsible for the latest developments. Much of the substance of these schemes, if successfully developed, can again be applied in a lesser degree to the smaller concern. Comparing the possible results from the smaller stations in the future, there seems, therefore, much hope for drawing the competitive level higher and higher every year.

There are, of course, undertakings operating with turbines of 1,000-kW and 2,000-kW size, but these can be looked on as being in a transition stage. There are remaining a large number of isolated concerns whose total output can only be expected to be about 500 to 1,000 kW. These are at present operated by small reciprocating steam engines often non-condensing.

* See fig. 1, p. 38, *Journal*, Inst. E.E., Vol. 58, No. 286, December, 1919.

There is also an outlook for these concerns by the use of oil engines. There are two main lines known popularly as the Diesel and semi-Diesel types. The cycle efficiency of these engines is extraordinarily high.

According to an analysis of performance by Sir Dugald Clerk, a fair result for a 500-h.p. Diesel engine is:—

Mechanical efficiency, 77,6 per cent.

Indicated thermal efficiency, 39.9 per cent.

Brake thermal efficiency, 31.2 per cent.

Since the mechanical efficiency is low, the brake thermal efficiency falls off rapidly at low load, which indicates the desirability of a series of sets of increasing size to deal with the bad load factor of small concerns.

The efficiency of much smaller engines of the same type is well maintained. The following figures may be of interest as representing results commercially attainable to-day.

Fuel consumption of small Diesel engines in pounds per b.h.p.-hour:—

	100 h.p.	150 h.p.
Full load ...	0.45	0.44
¾ load ...	0.47	0.46
½ load ...	0.54	0.52
¼ load ...	0.73	0.69

The brake efficiency corresponding to these figures, taking the oil as having 18,000 B.th.u. per lb., is:—

	100 h.p.	150 h.p.
Full load ...	31.4	32.1
¾ load ...	30.1	30.7
½ load ...	26.2	27.2
¼ load ...	19.4	20.5

The efficiency of semi-Diesel sets is very similar to the above.

The cost of all small prime movers of any type is proportionately high. The total costs of running these engines cannot be compared yet with those of the larger steam stations. Not only is the capital cost high, but the fuel cost is high. At the present time the cost of fuel oil is about £4 12s. 6d. a ton for a material of calorific value (lower) of about 18,000 B.th.u. per lb.

Recent estimates for a small output gave the following interesting figures:—

Total Generation Costs—Price Per Unit Sent Out.

Load.	170-kW Diesel.	50-kW Semi-Diesel.
Full ...	0.572d.	0.705d.
¾ ...	0.662	0.825
½ ...	0.865	1.09
¼ ...	1.495	2.05

Included in these costs are—

(*a*) Depreciation and interest.
(*b*) Waste, stores, renewals, and repairs.
(*c*) Fuel and lubricating oil.
(*d*) Cooling water.
(*e*) Labour.

At or about half load, the fuel cost is approximately half the total cost.

While such figures show that many of the small steam concerns, which will have to carry on alone for a number of years, can effect much progress by the use of such sets, a consciousness may still remain that reductions may and should be hoped for.

As an outlook for the future, it is not beyond imagination to expect processes for obtaining a greater oil yield from coal, especially should it be found possible to carry it in solution. Research seems to be feeling its way in this direction. It is already known that oil may be made to carry solid carbon, if sufficiently finely divided, and workers are busy endeavouring to get more and more of the coal content in liquid form. These may ultimately be chemical and not necessarily simple distillation processes.

Finally, in some cases there may be found a use for the exhaust heat from the small reciprocating engines. This may be utilised for warming buildings, heating baths, and providing cheap hot water for public wash-houses.

Thus, even in the smallest concern, there is room for progress, effort, and hope.

THE DEVELOPMENT OF SMALL WATER-POWERS AND LOW FALLS.

By Prof. A. H. GIBSON, D.Sc., M.Inst.C.E., M.I.Mech.E.

The physical characteristics of a country determine whether its potential water powers shall be mainly available at sites each giving a comparatively large output or at a large number of sites of small individual capacity. In such a country as Great Britain the rivers in general have too gradual a fall, and the streams of the steeper ground carry too little water to permit of the large development of water power at any one site. On the other hand, there are innumerable sites scattered throughout the country, on all but the most sluggish rivers, at which small water powers of from 10 to 200 h.p. might readily be developed.

As a general rule, in all the older industrial countries the early manufacturing communities were grouped around the more easily available water-power sites, and extensive use was made of such power, notably for the production of textiles and for milling. The development of the steam engine and of railway transit, the growth of the size of factories beyond the capacity of the installed water-power plants, and the improvements in methods of manufacture necessitating a steadiness of drive which could not be furnished by the water-wheels then employed, led to the abandonment of the majority of such installations. During the last decade, however, there has been a general revival of interest in these small water powers. The improvement of the water turbine and the great development of electrical appliances have been largely responsible for this revival, which has been accelerated by the great advance in the cost of fuels of recent years.

Photo by] A. H. Gibson. *[Lafayette.*

As an indication of the situation in one particular area, it is of interest to note that in 1920 there were 600 water-power sites in the West Riding of Yorkshire at which between 16,000 and 17,000 h.p. was being developed, and 132 sites at that date still unused for power purposes.

Some approximate idea of the water power likely to be available from the small rivers of this country may be deduced from an investigation of the Wiltshire Avon in 1919 on behalf of the Board of Trade Water Power Resources Committee. The size of the catchment area of this river (674 sq. miles) is fairly typical and the rainfall about the average for England. From this area an aggregate output of 650 kW is already, or is being, developed, while the investigation showed that the total possible output is about 3,000 kW, or 4.4 kilowatts of continuous 24-hour power per square mile of catchment area, which, if applied to the whole area of England, would give an aggregate continuous output of 220,000 kW. These figures relate to installations which are designed to utilise the natural flow of the river, unregulated by storage.

From the nature of the case, low-head installations are only to be found on rivers or streams of small gradient. This in general renders it impossible to conserve the wet seasonal run-off for use in dry seasons, since not only does the small head necessitate a very large volume of storage, but, owing to the flatness of the gradients, such storage would usually cause the submergence of a considerable area of land. Moreover, the seasonal fluctuation of head due to the varying level of the storage reservoir would be a large proportion of the average working head, and would not be conducive to high efficiency in operation.

For these reasons, if a low-head installation is to form the sole source of power, it can only be rated with reference to the capacity of the site under the conditions giving rise to minimum output. In many cases this is determined by the amount of water available under dry-weather conditions. Often, however, owing to the banking-up of the tail water under flood conditions, the working head is so reduced as to render the output a minimum at such times. If thus designed for minimum flow conditions, any excess water at other seasons is wasted. Where, however, the installation can be used in conjunction with a steam station a much more liberal allowance of plant is economically advisable. Much depends upon local circumstances, but, as a general rule, it will pay to install such a turbine capacity as may be kept running at full power during the wettest six months of the year.

Although storage in the broad sense is not feasible, it is often possible to provide such modified storage, or pondage, above the site as will enable the daily flow during the period over which the plant is idle to be impounded for use during the working day. In this way, with an eight-hour working day, the output in horse power may be trebled.

In a few modern installations in this country, designed for factory service, in which even this modified amount of storage is impracticable, the turbines are allowed to run continuously and perform the duty of pumping water up to an elevated storage reservoir in the vicinity, from which it is supplied to a series of high-head turbines developing the motive power as required. Although this involves the provision of two sets of turbines, as well as of a pipe line, centrifugal pumps, and an elevated storage reservoir, experience shows that where the physical characteristics of the site are suitable, such a scheme is economically feasible.

Modern developments in turbine design have done much to render low-head development economically more attractive. The earlier turbines for such heads were essentially low-speed machines. The governing mechanisms were crude and the difficulties in the way of accurate speed regulation great, and although their speed was not too low to permit of the direct driving of mill machinery, it necessitated a comparatively expensive generator if used for electric driving.

During the past ten years, however, new types of runner have been evolved, which permit of speeds at least three times as great as were common in the past being attained with satisfactorily high efficiencies, and this has rendered commercially possible the development

of many comparatively large low-head schemes. Investigation and invention on these lines is actively proceeding, and it is probable that the low-head turbines of the future will show still more marked improvements in simplicity of construction and in speed over those in use to-day.

Developments in turbine governors have also enabled the problem of accurate speed regulation to be satisfactorily solved, and in this respect the low-head turbine plant is little inferior to the modern steam plant.

As a compensation for its disadvantages, the simple low-head scheme has the advantage of being comparatively cheap to construct and maintain. Such head works as are necessary are not expensive, and no pipe line is required. For high efficiency, however, especially with the modern high-speed type of runner, very careful design of the turbine setting is necessary, especially as regards the draught tube, in order to prevent undue losses at discharge.

Of recent years several schemes have been suggested for reducing the loss of power due to the reduction in working head in a low-head plant, due to raising of the tail-race level in times of flood. In one of these, the Moody ejector turbine, a cylindrical gate at the top of the draught tube admits pressure water to the draught tube in times of flood. This, by its ejector action, reduces the pressure in the draught tube, and tests show that in this way the capacity of the turbine may be increased appreciably. In another arrangement advantage is taken of the fact that if the water passing over a waste weir of suitable design, in times of flood, is discharged into the tail-race, it forms a standing wave, and that the surface level at the up-stream side of this wave is lower than the normal level without the waste weir in operation. In this way the tail-race level at the point of discharge of the draught tube may be reduced, and the working head increased. While these schemes are as yet rather in the experimental stage, they offer very distinct possibilities, and their successful development will largely increase the economic value of many low-head schemes.

As already indicated, in order to make the best use of the average small water-power scheme, it should be used in combination with a steam, gas, or oil-fuel plant, whose maximum capacity should be such that it will augment the minimum seasonal output of the hydraulic plant up to the capacity necessitated by the demand.

The best method of operation of such a combined plant depends largely on the relative capacities of the two sections, and on whether any appreciable amount of water storage is available. Where a steam plant is installed, and where the water power is large compared with the steam power, it will in general pay to operate the steam plant continuously, since for maximum economy such a plant requires to operate at more or less constant load corresponding to full load on one or more units. On the other hand, if the water power forms a relatively small proportion of the whole, it should be utilised to its full extent wherever possible, the steam plant taking the peak loads. For intermediate conditions much depends upon the load factor and generally upon local circumstances.

As an excellent example of the economy rendered possible by the co-operation of a steam and a hydro-electric station, the power plant of the Chester Corporation may be cited. Here the capacity of the steam plant is 1,240 kW and of the hydro-electric section 635 kW, under a head of 9 feet. This section works under difficult conditions owing to the fact that the river is tidal and is unregulated, and the working head varies from 1 ft. to 9 ft. From statistics quoted in the final report of the Board of Trade Water Power Resources Committee, it appears that its mean effective annual output during the 7.5 years ending in March, 1921, was 220 kW. The average number of hours run per annum was 8,323, or 95 per cent. of the maximum possible time, and the units generated were 1.83 million kWh. During this period the steam plant generated 2.05 million kWh per annum. During the five years ending in October, 1918, 51 per cent. of the total energy sold was generated by the hydro-electric plant. Had this energy been generated by a steam plant operating under average conditions similar to those actually obtaining, the additional fuel consumption would have been 3,980 tons per annum, equivalent to 18 tons per kW generated. The average annual costs of the hydro-electric section, including sinking fund and interest on capital, amount to 0.293d. per kWh generated, while the corresponding costs of the steam plant amount to approximately 1.05d. per unit. The corresponding costs per kWh sold were approximately 0.35d. and 1.45d.

A somewhat similar example of the use of a comparatively small hydro plant is afforded by the power plant of the Salisbury Electric Light and Power Co., Ltd. This has a total capacity of 600 kW, the normal maximum output of the hydro-electric section being only between 30 and 35 kW. During the ten years 1911-20, this section averaged 8,200 running hours per annum, and generated 120,000 kWh per annum, the mean effective annual output being 23.2 kW, or 66 per cent. of the maximum output. During the same period the steam station generated 571,000 kWh, or only three times as much as the hydro-electric section. The saving of coal due to the latter station is estimated at 530 tons per annum, equivalent to 22.8 tons per kW per annum.

Owing to the fact that the cost of an electrical transmission line, per unit of power transmitted, increases very rapidly as the power is diminished, the distance to which it is economically possible to transmit the output from a water-power installation diminishes rapidly with its size, and the output from the average small power scheme must be absorbed at a comparatively small distance from the site. This renders the isolated small power economically useless except for strictly local purposes.

Where, however, a number of such powers are not too far apart, they may be linked by short spur lines into a common transmission line, and the aggregate output may then be sufficiently great to warrant the cost of transmission to some considerable distance. In this manner, the entire output of a small river might readily be absorbed, at a number of small stations at physically favourable sites between its uplands and the sea. Such a scheme has been outlined by Mr. S. E. Britton, M.I.E.E., electrical engineer to the City of Chester, for the development of the River Dee between Chester and Llangollen. The length of river between these points is 47 miles and the fall 220 ft. It is suggested that this reach of the river could be most economically utilised by the erection of sixteen weirs and hydro-electric stations at various points. The heights of the proposed weirs would vary from 7.5 to 14 ft., and in one case a head of 37 ft. would be obtained by the use of a short pressure tunnel. Fifteen of these stations would be equipped with turbines of the same size.

It is estimated that in this way approximately 60 million kWh could be generated annually, equivalent to an average output of about 6,820 kW. The total cost based on the experience of the cost of installation of the Chester hydro-electric station, with an addition of 70 to 100 per cent. on various items to meet the increased charges ruling at the time of the report, including transmission lines but not wayleaves, is estimated at £72,240, or only £10.6 per average kW. It is suggested that a district extending from three to five miles on either side of the river, of an area of 200 sq. miles, might be served by this scheme, the average annual power delivered being about 5,460 kW.

For the successful working of such schemes the stations must operate automatically to reduce the cost of superintendence, and they must be simple and robust. In one system suggested by Dr. Steinmetz, each turbine is coupled to an alternator of the induction generator type, which will supply current to the mains in proportion to the water power available, up to the limits of its capacity. The necessary starting arrangements are simple, and may be controlled from some distant point, or the starting and stopping may be arranged so as to

be regulated automatically by the level of the head water. One of the stations is a controlling station, and supplies the magnetising current for all the small alternators. The others are of the simplest type, consisting simply of a building to house the turbine and generator. The only supervision required is a periodic visit to each unit to attend to lubrication and to clear the intake racks.

The essential features in such a scheme are the cheapness and simplicity of the stations, the low cost of supervision, and the large proportion of the potential water power which may be utilised under favourable circumstances. It may be developed gradually, station after station being added as the demand grows, so that the initial financial outlay need not be large. The electric mains not only act as collectors, but are equally valuable as distributors. All the small towns, villages, and farms in the area may readily be linked on to such a system. If the system is in the neighbourhood of a large town having a central steam station, if this be linked into the circuit many of the drawbacks due to the seasonal irregularity of the water supply may be avoided, while since the water-power stations usually give their maximum seasonal output when the total demand for power is a maximum, this appreciably increases the maximum capacity of the system as a whole.

Such a linking-up of a large number of the small water powers of the country in conjunction with one or more large steam stations promises to be a feature of the not remote future, and would appear to be necessary if the utmost use is to be made of these powers.

The general use of electrical power which it would render possible, especially in rural districts, would probably have a marked effect on the social life of the community. It would go far towards reviving and extending those small local industries which should form an essential feature of the ideal rural township, while the extension of its use in agriculture should do much towards making that industry both financially and socially more attractive. Commercially such undertakings may not appear to be of great importance, but as a factor in promoting the welfare of the community, economic and political, their influence can hardly be over-estimated.

OVERHEAD ELECTRIC POWER TRANSMISSION.

By WILLIAM T. TAYLOR, M.Inst.C.E., M.I.E.E.

Up to the present time, long-distance extra-high voltage power transmission systems are, broadly speaking, non-existent in this country. The principal reasons for the absence of such systems can be taken as being fundamental to the country and to the inherent conditions. Due to advances made in the science of electric transmission engineering, steam and hydraulic power plant and their auxiliaries, transmission will be more generally used in the future. The writer contemplates that we are almost on the threshold of a new era of power transmission work which will be brought about by the development of water power; by the concentration of and consolidation of large steam plants; by electrification of railways; and by a more confident outlook and effort in meeting competition at the load centres respectively.

W. T. Taylor.

Due mainly to growth and to the more rapid changes and to advancing knowledge of the design of power transmission lines, no fixed set of standards has so far been universally adopted. As a matter of fact, all manufacturers and designers of importance are not quite ready (as it were) to "pool" their structural designs, &c. However, there is reason to believe that more attention will in future be directed toward the universal adoption of standards for all lines at the more ordinary voltages. At the present time the transmission voltage range is very wide. In this country, taking 11,000-volt transmission lines as the ordinary low-range limit—using the term "transmission lines" in its broadest sense—the maximum voltage range is nearly 4 to 1, whereas in America (U.S.A.) the maximum voltage range is nearly 20 to 1, or five times greater than the maximum operating voltage in this country. However, the writer ventures to predict that, within the next ten years, we shall have long-distance overhead power transmission lines in this country operating at 100,000 volts or above. The voltage of to-day is 1,000 times higher than it was 40 years ago, *i.e.*, from 220 to 220,000 volts.

One important *future* transmission power problem in this country will be bulk power supply. The change will mean that the characteristics of the load will be different, and therefore the load of each electricity supply undertaking should be definitely known, because the bulk-power supply company engineers will have to keep before them the opportunity of improving the system load factor by diversity of demand or by actually high load factor service; and that a more definite knowledge concerning power factor, load balance, and momentary and sustained peaks will become necessary to enable the engineers to determine the most economical transmission line conditions, &c. New penalty clauses will come into force with regard to damage that the bulk power customers will suffer if service is interrupted momentarily or for various extended periods. The more important transmission systems will have duplicate transmission lines and/or ring lines, and the line-circuits will invariably be on separate towers. All the more important load centres will be fed from two or more directions. The writer further ventures to predict that, eventually, power transmission lines in this country will extend from coast to coast.*

* The question of electrical limits of power transmission has little practical value in this country, for the reason that, if desired, we can to-day transmit electric power in bulk to distances well over 1,000 miles.

Transmission lines are usually located so that they traverse the less populous territory where their costs, and the penalties of accidents, are less severe. The principal governing factors in the design of the most economical transmission line are: carrying capacity, load factor, distance of transmission, specific cost of energy at the receiving end, and low annual expense on the capital invested. When the transmission line is to be designed simply from the viewpoint of the annual expense of the investment and the electrical energy losses in the transformers, the transmission line, and phase compensators, the total cost will be made up of the arithmetical sum of costs of energy losses, towers, conductors, and earth wire and telephone wires, insulators, transformers, converters (if any), switchgear, land and buildings, wayleaves, phase compensators, and miscellaneous. The cost due to the I^2R losses (for all big lines under reference) will be the predominating factor of the first cost, and its variation will have a direct influence on the total cost. In the design, transmission lines in this country will rarely be limited by the consideration of corona.

A carefully-designed transmission line should have the longest life consistent with reasonable first cost. One of the great dangers in making provision for future possibilities is that, because of the changes from year to year, there is no certainty that 12 years hence or even two years hence, we shall want to install the same design as to-day. The lay-out of the transmission system is of prime importance in ensuring a high degree of continuity of service, and in this regard future installations will follow the leading features of the best and most economical line location and correct line engineering. The development of many of the future large power transmission systems will, due to unalterable circumtances, virtually be a compromise between what is desired and what future circumstances demand and permit. Obviously, an exact decision of the type of transmission line, character of supports, total conductor, and earth wire capacity, &c., which will provide the highest *ultimate* economy as well as excellence of/or the best service, is perhaps impossible. The designer must, of course, determine as accurately as possible, the most economical voltage, the most economical span length between the towers, the most economical size of conductors, and the most economical phase compensation, and, the most he can do is to use good judgment (based on a broad and sound practical experience) in estimating future developments of this character.

For several reasons, great difficulty may be encountered in this country in obtaining easements covering the location of towers and suspension of conductors and wires operating at the said very high *future* voltages. So far, there seems to be no general standard by which the width of a right-of-way may be determined. Where two power lines are to be located over one right-of-way, it is desirable to have the lines far enough apart so that the towers of one line will not strike the other line on falling. In cases where it is important to use the right-of-way in the most economical manner, it would be best to use two-circuit towers having the conductors of each circuit arranged in a vertical plane on one side of the towers. On the other hand, a maximum width of right-of-way is required when conductors are arranged in a horizontal plane. In computing the side-swing, allowance must be made for swing of the suspension insulators; side swing of conductors should therefore be based on the longest span ordinarily used, and the extra width should be secured wherever exceptionally long spans are made.

The future line supports, for "first-class" installations, will consist of rigid (wide base) structural steel towers, the square or tripod latticed structural steel poles, the tubular steel pole, the concrete pole, and the semi-flexible pole. In the future, much less use will be made of wooden poles and structures on all first-class installations. In long-distance transmission lines carrying large amounts of electric power, the voltage of transmission is necessarily high and the size of conductors large; therefore, sufficiently strong and high structures are required for the line supports. Experience shows that structural steel is the most suitable and, in general, the most economical class of material to use for this kind of line supports.

As yet there is no established relationship between the span and sag, and the separation between conductors. However, because of the high stress at which the conductors may have to work to obtain the highest ground clearance and longest possible span with a given height of towers, specifications should be very rigid. Conductors must, of course, be spaced so as to provide sufficient clearance between adjoining conductors and between their supports. The most economical span of towers is defined by the cost of towers and insulators. The weight of a steel tower is very much dependent on the tension of conductors either in unbalance or in the deflection of the line. The failure of steel towers has almost invariably been caused by the buckling of main compression members. Future practice is sure to prohibit the use of any castings in the main structure of transmission line supports.

There is still considerable difference of opinion as to what should be taken as the maximum loading in designing a transmission line. Designers are at variance as to a proper estimate of the unbalanced tension. Two widely different conditions are assumed, namely: (*a*) that line supports should have a maximum possible unbalance in tension when the conductors are totally broken down on one side; (*b*) that line supports should have a small unbalance when a single conductor is broken on one side. Past experience proves that conductors very rarely break off totally on one side. It seems that (*a*) is too much on the heavy side, requiring thicker steel, while (*b*) leans too much on the lighter weight or thinner section of steel structure. As a compromise, it is possible that future designers will allow for one of (*b*) for every three or four of (*a*). The (*b*) type may take the place of dead-end or angle towers. In determining the design of towers, a good basis is to assume that sleet will form $\frac{1}{2}$ in. thick and weigh $\frac{1}{2}$ lb. per ft. run at the windage of 20 lb. per sq. ft. of normal plane area. Experience indicates that *heavy* sleet will not form when the wind pressure is high. In determining the mechanical factor of safety, it is necessary to assume certain properties of the factor as safeguarding each of the possible elements of danger, such as the error of design, workmanship, excess loads, deterioration of materials, and other considerations.

The weight of line insulators is dependent on the transmission voltage. In future transmission development, the suspension type of insulator will come into use. Up to the present time the pin type of insulator is used exclusively, and its use will continue for voltages up to about 66,000 volts, beyond which the suspension type of insulator will be exclusively used. In special cases, where a higher factor of safety is required, the suspension type of insulator may be used for very much lower voltages than 66,000 volts, but the relative cost will be greater. When considering the most economical span, the insulators tend to make it longer than the most economical span for the towers alone. The rated voltage principally defines the cost of insulators, while the cost is mainly dependent on the weight of insulators. For a given line, a wider right-of-way, a higher tower, and a longer cross-arm is required for the suspension type than the pin type of insulator. The cost of a suspension insulator string for a given voltage* in dependent on the number and the size of units, and is a minimum for a certain number and size. The writer points out these important considerations because they are applicable to designs yet to come into practice in this country.

Without a shadow of doubt, future long-distance

*The suspension insulator string should preferably be graded and shielded in such a way as to increase the insulation and decrease the voltage stress on those units of the string near the line-conductor so that these units can absorb the excess voltages due to switching, &c.

transmission lines will, universally, operate at the highest commercial or permissible voltage. In this respect it is interesting at the moment to note, in the technical Press, the relative merits of the lately-installed 220,000-volt* system, and, incidentally, the writer would like to remark that eleven years ago he predicted the operation within ten years of such a transmission voltage.

The near future is likely to see a change in the empirical formula, expressing the most economical transmission voltage, for the reason that it omits the important factor, *specific cost of energy*. The amount and cost of power to be transmitted is a very important factor in determining the economical transmission voltage.

In the writer's opinion, the transmission system and voltages in common use—without in any way neglecting the introduction of new systems, such as the so-called "transverter" system—will be the three-phase, high-pressure transmission from generating stations to sub-stations or to other generating stations, or to both, for interconnection of power systems, at voltages of 20,000 to 100,000 volts or above, and three-phase intermediate distribution from generating stations to sub-stations or generating stations, or both for interconnection of power stations at about 6,000 volts to 20,000 volts. The above-mentioned transmission lines may be run for short or long distances, and may be tapped at any desired point. In the distant future we shall see the whole of the industrial parts of this country connected with a large network of interconnecting transmission lines between load centres, and these load centres will be supplied from local and super-steam stations and steam stations at the mines, and hydro-electric stations from sites situated both very far and relatively near the said load centres. The continuity of service will in consequence be well assured, and the necessity for spare plant will be greatly reduced, far beyond what can be obtained from any source of power supply in existence here to-day. The successful operation of these interconnected transmission systems will require complete co-operation of load dispatchers in control of the system operations.

Always when in doubt, install the higher-voltage system, which will, in the course of time, justify its adoption by reason of future growth not always apparent at the time the choice is made. A fairly common mistake has been the under-estimation of the ultimate demand for power and the consequent adoption of far too low a transmission voltage.

Looking well into the distant future—with particular reference to certain of our Colonies—the mechanical elements of design with the *very high* voltages will involve structural strains of a magnitude not hitherto encountered. The insulation and the separation of conductors will offer new features; the voltage regulation will require large equipment of an unusual type. The total losses on the line may make up a load on open-circuit sufficient to burn-out, due to overload, any one or perhaps more main generators, group of transformers, or converters, unless special conditions of using reversed field excitation, &c., are used.

As the total cost of transmission is practically inversely proportional to the power factor of transmission, more attention than is now given to present-day electric power systems must be devoted to the matter of the most economical phase compensation. Obviously, phase compensation is economical when the efficiency of transmission is improved and the annual expense of the system per unit of energy is decreased thereby. Large transmission systems such as we shall have in future will not be able to give satisfactory service without synchronous machines (condensers), and voltage control will not be accomplished satisfactorily at the generator alone. For successful operation of the lines anticipated, it will be necessary to have practically a uniform voltage along the line not only for one load, but for all loads. By maintaining constant voltage along the line, troubles, such as voltage rise due to dropping loads, and insulation strain, will be reduced. Synchronous condensers (distributed along the line) will have a tendency to act as automatic magnetic brakes against increases in voltage. In all cases, voltage regulation is greatly impaired by low power factor, and the efficiency of the line will depend on the amount and power factor of the load. When the power factor is not very low, the advantage of installing synchronous condensers, for lines *not* carrying large amounts of power, is questionable. The installation of synchronous condensers not only requires a certain amount of investment which is high, but the machines and transformers also consume energy to operate them. Moreover, the total energy consumed has to be transmitted over the line.

In the opinion of the writer, the use of earth wires should be encouraged, as their use is effective in reducing the higher induced voltages sufficiently to bring them close to the value which high-voltage apparatus and line and transformer and switch insulators can safely withstand. The *proper location* of the overhead earth wires is, obviously, above the power circuits, and not below them, which is the common practice in this country.

Lightning, switching and other phenomena cause disturbances on the line conductors. Lightning may affect all the line circuits simultaneously, but if circuits have different routes, simultaneous lightning troubles are not likely. In the opinion of the writer, the proper value of a section or length of iron wire as line conductor installed at the terminal ends of extra-high-voltage power lines as a protection against lightning and short-circuit current is not understood as it should be. By virtue of the higher reactance of such lines it might be possible in some cases to obtain sufficient reactance without the addition of current-limiting reactance applied in other ways. This is a question requiring investigation.

For long spans, where the strength of hard-drawn copper is not sufficient, the copper-clad steel wire is sure to find a ready application, and, in certain cases perhaps, the steel-cored aluminium cable may be used. At the present time copper-clad conductor is on the market which has a strength 150 per cent. greater than copper conductor. The limiting of short circuits is most desirable where aluminium conductor is used. The skin effect is quite appreciable in aluminium and copper cable with a steel core. Where conductors are supported on the same plane or in vertical order, the line current may be considerably unbalanced under no-load conditions. At the present time there is no recognised standard or basis for conductor calculations, with particular reference to the *maximum* and *average* values of power, voltage and power factor, &c. In the calculation of voltage loss for all the overhead extra-high voltage (a.c.) power lines now operating in this country, the simple impedance method, which neglects the electrostatic capacity of the line, may be used. It will give sufficiently accurate results for all practical purposes. The accuracy will depend largely upon the length and voltage of line, frequency and power factor. The total impedance drop should always be distinguished from the voltage drop. In the case of long lines (over and above 50 miles) the methods likely to come into general use are the different forms of hyperbolic functions and the convergent series. Many different graphical solutions for voltage drop and power loss are sure to be employed.

A transmission line is subject to damage maliciously done or due to accident, but, neglecting those, the writer considers that, at the present time, the weakest link in the complete transmission system is the insulator bushings at the line end and on extra-high-voltage transformers and switches.

Many years have gone by since the writer first recommended the delta-star connection (star on the transmission-line side) with neutral point earthed as the best all-round transformer connection; this practice is still recommended as the best.

* See *Journal* Inst.E.E., Vols. 46 and 47, 1911. On p. 167, Vol. 47, the writer stated: "I do not hesitate to predict that during the next ten years transmission lines will be operated at above 200,000 volts, but as to the ultimate voltage for practical operation of our lines I am unable to express an opinion."

THE HOMECOMING OF ELECTRICITY.

By J. W. BEAUCHAMP, M.I.E.E., Director and Secretary of the British Electrical Development Association.

Characteristic of "The Review," as of the industry for which it has spoken for half a century, is the request that contributors to this issue should look forward rather than dwell upon the past.

The layman who loses no opportunity of observing that "electricity is in its infancy" is a stock jest amongst us, but we have perhaps been unfair to him; intuition rather than judgment, and an outlook unobstructed by knowledge of detail, may have revealed the truth that our business is always in its infancy in some direction or other, renewing its youth continually; the triumphs of the telegraph and telephone have become commonplace, electric lighting and power a necessity, and to-day we invade the field of heating, to-morrow, perhaps, to tap new sources of power, and again find electricity the readiest means of using them.

It is of particular interest at this moment to consider the infancy of electricity in relation to the home—it may promise something more than the saving of a little work; in rescuing the Englishman's wife from the dungeon beneath his castle in which she has lived so long, we are perhaps setting in motion a far-reaching social change, one which may give us the benefits sought by the constructive communist whilst preserving that individuality of life so dear to us, and probably essential to the fullest development of the human being.

The engineer of a large supply undertaking belonging to a municipality regarded as a model of local government, has recently stated that: "Electrification of the home is capable, even within the limits imposed to-day, of producing a demand for electricity far greater than all the other fields at present open to us."

J. W. Beauchamp.

In considering the electrification of the home, it is of interest to start not at the generating station or the mains, but in the house, and to work backward and outward, regarding the home as a unit or focus of social life, the family, its life and welfare, as the real object of the activities of the world, for scarcely anything is done which is not in some way or other designed to improve the individual, to make his life safer, fuller, and more productive of contentment to himself, and of benefit to the community as a whole.

Installation Work.—Much has been expected from the various surface wiring systems which have been brought out to reduce cost and to give us the cheapness and flexibility of "Continental wiring" without falling below the measure of safety which seems desirable in this country.

Although there are to-day many systems, so far nothing strikingly novel has emerged in this direction, nothing which can be described as a departure in principle, so there is still room for the ingenious inventor who can forget everything that has been done and approach from some new angle the problem of feeding millions of lamp points and outlets.

In Dundee some house wiring has recently been carried out by using one of the standard surface cables and running solely upon the walls of the building, along picture rails, and in similar positions, the lighting being effected by brackets and indirect illumination from the ceiling, heating and cooking from outlets on the walls in the usual way.

There is perhaps nothing very new about this method, but it contains a new idea, as the whole of the wiring installation is carried out in the vertical plane, and not in the horizontal; neither ceiling nor floor is interfered with—a valuable and distinct departure.

Those who carry out installation work to-day should use every endeavour to increase the number of outlets provided in houses and other buildings—this is of importance, and will become more so as tariffs are simplified, enabling any appliance to be attached to any part of an installation which has sufficient capacity to supply it.

A little trouble in selling extra outlets to consumers when installation work is in hand will bring a good reward to the contractor and the supply undertaking; the lack of ample outlet facilities is one of the most serious checks on the steady sale of appliances, which should be possible from time to time to every consumer.

Our wiring rules have been slowly hammered out, and apparently are never to be complete; the immediate future will probably see further modification of them, rather in the direction of setting up different standards for different classes of work, and in that way reducing the average stringency of installation requirements.

It is becoming obvious that electricity is so very much safer than any of the media which it replaces that we have unnecessarily hampered its development by insistence upon a standard for work of all classes which might well be modified in relation to the character of the buildings, the positions being treated, or to the amount of responsibility upon the installation when in use.

Lighting.—The lamp of to-day is cheaper than before the war, a testimony to the enterprise of the British lamp maker and to the immense demand which the world makes upon him at the present time; working as he must with costs perhaps 75 per cent. higher than in 1914, he now offers a modern lamp, in itself a triumph of the manufacturer's art, at less than pre-war figures, and when one analyses the cost of electric lighting, comparing the amount spent on lamps with the amount spent on electricity over a term of years, it becomes obvious that there is little to be gained by small economies in the buying of lamps concerning the manufacture and history of which one may be uncertain.

It is also worth while to bear in mind that the great lamp business of this country has done, and continues to do, a large amount of advertising; primarily intended to sell lamps, it has also had a most beneficial effect upon the industry as a whole. You cannot advertise lamps without telling the advantages of the electric light, and you cannot tell that story without, by inference, reminding the public of the advantages of electricity for all purposes. In this way the lamp makers' advertising has been valuable, and has brought to all sections much business not directly connected with the sale of lamps.

Electric Cookery.—This is becoming a subject by itself, almost with a literature of its own, and in the past two years development has been extremely rapid, resulting in figures and experience which show this business to be most desirable and unaccompanied by

many difficulties which were at first anticipated in connection with it.

The apparatus has been improved out of all recognition, and although there are hints of new and radical departures in method, the electric cooker may, with small improvement and slight variation, become a standard line almost immediately.

The most practical method and the safest for pushing the heating and cooking load at the present time is for supply undertakings, without waiting for further development, immediately to engage themselves in the business in a more or less modest way according to their conditions.

There can hardly be any supply undertaking which cannot find a dozen or so of consumers so situated on its network that a cookery supply is possible, and this should be put in action at the earliest moment. Experience will be gained, the manufacturer of cookers encouraged, and within a short time each engineer will know for himself exactly what the modern cooker can do, what it means to him in revenue, and in demand upon his plant and cables. To say that it will be an agreeable surprise is only to generalise from the increasing stream of experiences which come to hand.

In any case where it is not able to grapple with the domestic cooking business at once, a supply undertaking may well direct its attention to commercial cookery, the provision of apparatus in restaurants and other places where food is prepared on a commercial scale; the load factor of such apparatus is high, consequently its first cost is less alarming to the buyer, and experiences already gained are so promising as to show that in many operations quite a good price per unit gives every satisfaction.

Already notable success has been achieved in the cooking of pastry, frying of fish, roasting and boiling of meat, poultry, &c., for sale as cooked food. This is a line of business worth exploring. The apparatus is often so clean and attractive as to make a valuable shop or window display and generally impart a high-class air to the business.

There are great possibilities in this field of commercial cookery; already a great deal has been done on the Continent in the baking of bread and biscuits on a large scale, and within recent weeks an American bread oven of a novel type has been put into use here and illustrated in the technical Press.

The use of electricity for baking bread should offer a desirable night load to the supply undertakings.

Electric Fires.—The popularity of the electric fire grows so rapidly that in some cases the resulting load is embarrassing, but this need not be the case where full electrification takes place; a mixture of "occasional" fires and steadily used cookers produces a desirable load factor, but there may be a few cases where the cleanliness and advantage of the electric fire lead to such a considerable use during cold weather as to produce an embarrassing short-hour demand unassociated with any great annual revenue.

Recently, however, engineers with a considerable load of this kind have stated that the so-called "cold snap peak," although noticeable, is not sufficiently serious to deter them from pursuing the business, and it will probably disappear in the general rising of the load curve which is now taking place owing to the increasing variety of uses of electricity.

In acute cases it is worth while to consider whether the time has not come to deal with this difficulty by means of heat accumulation.

Water Heating.—The difficult problem of heating water by means of electrical energy has already been tackled with considerable success.

For small quantities the quick-boiling kettle and the various types of geyser are in extended use. Beyond their range, however, comes the possibility of heat accumulation, and already a good deal is being done in districts where an off-peak or night rate is in force.

It is well worth while at the present time for the supply engineer to give careful attention to this question of heat accumulation and night rates, and to call upon the manufacturers to produce suitable apparatus, and in the same way the maker of heating and cooking appliances might devote some of his time to the design of the essentially simple appliances necessary for this purpose, both for the heating of water and for the warming of rooms.

In the latter case we have perhaps to meet the principal and rather important drawback with the accumulation stove, that it gives off heat in the convective form, which is not popular or likely to become so in this country, but there seems no reason why a combination of the heat-accumulating convective stove with radiant elements should not be successful, putting upon the night-rate supply the heavy work of storing heat energy for warming the air of the room to a reasonable degree and making available also a moderate amount of radiant energy for use at will, by the occupant of the room, at ordinary rates and as a supplement to the cheaper energy taken during the night.

Although this problem is not new in England, its possibilities have been obscured by the feeling that it would hardly be practicable to sell electricity for heating on a large scale from any thermal generating station; but it is quite clear, from inspection of the load charts of power stations, even in industrial areas, that there remain possibilities of supply for heating in this way, the more so as the cheapness of electricity supply for all purposes must depend increasingly upon improved load factor.

It has become obvious already that supply schemes and long-distance transmissions under modern conditions and at present prices are hardly possible at the load factors generally obtained in residential districts, and can only be entirely satisfactory when the costly investment is loaded up to a high degree.

Power in the Home.—Here we have a field which neither gas nor fuel can touch; electricity alone makes it possible to bring mechanical aid to the labour of the home.

Already the vacuum cleaner is a commonplace item of domestic equipment.

The washing machine is selling in this country in an encouraging way, and many homes use electric motors for small tasks, such as polishing, driving sewing machines and fans, &c.

From one district a report comes of the brisk sale of central suction plants in homes of moderate size, the motor and exhauster being placed in the basement and the house piped with outlets in each room.

Here at least is a valuable line for the contractor to explore, and this may gradually bring us to the stage where mechanical power in the home is provided by one fixed electric motor rather than by a multiplicity of small ones carried about, one on each piece of apparatus.

It may sound fantastic to suggest turning the scullery into an engineering workshop, but it does not seem impossible to devise some simple countershaft with a motor which would look after the suction cleaning all over the house and be easily geared to a washing machine, boot or plate polisher, or other small apparatus.

Design and Construction of Apparatus.—Great strides have been made in the construction of domestic electrical apparatus; considering alone the heating and cooking appliance, it may be argued that it is little different in essence to-day as compared with ten years ago, but in fact the changes have been great. To make practical and "fool proof" appliances has not proved so easy as appeared at first, and the design of the modern cooker covers considerations with regard to the transmission of heat, expansion, and contraction, the production of alloys and insulating material—all of which together make the difference between an electric cooker and a mere box containing heating elements.

In addition it has been necessary to study practical details of importance to the user.

The equipment, as we know it, represents the needs and

the thought of the supply engineer, the manufacturer, and the cook, but still there are pieces of apparatus so essentially simple that the makers have not always thought it necessary to improve in details as the years go by—when it becomes necessary to carry out repairs one may still find nuts stamped out of sheet metal and tapped so badly that it is impossible to secure good contact without damaging the element wire; there is in some cases also room for improvement in design, temperature gradients across connections between heating element and conductor are too sharp, bolts and strips corrode too rapidly, and offer difficulty in carrying out repairs. Continued attention to these points is desirable, the more so as such improvements are generally inexpensive.

It is perhaps hardly safe to mention the question of plugs and connectors, the lack of interchangeability, and the necessity in many cases for more mechanical treatment of the terminals, and of the joints, generally too numerous, between the actual conductor wire of the installation and the element wire in the fire or other appliance.

There is still room for improvement in these accessories, and in connection with electric heating apparatus it may be taken as an axiom that if anything can possibly get loose in the course of working, it will certainly do so. It would not be unfair to say that many so-called cooker and fire faults which, in the mind of the consumer, are debited to the electric method, are really due to small and avoidable failures in connection with cords, wiring accessories, &c.

Influence of Electricity on Home Design, Cost and Maintenance.—A good deal has been said about the influence of electricity on the cost of running a home; certainly too much has not been said—the economy, particularly over a long period of time, is very remarkable. Not only are furnishings, fabrics, and even the clothes of the occupants made to last longer, the latter perhaps a two-edged consideration with regard to the housewife, but all these things remain in better average condition. Few people change expensive items of furnishings and equipment until they have come to such a condition that it is no longer pleasant to look at them by day or by artificial light, but where fires are cut out of the home and dirt is removed by sunction, the freshness and general condition of the equipment can be maintained over a very much longer period.

The influence, however, of the electric method is most marked on the first cost of building; taking an area where at the present time—and there are many—rates for electricity supply are sufficiently competitive with gas or coal, it becomes possible to restrict the use of fuel to one, or perhaps two, points, and to enjoy the advantages of electric light throughout, heating in most positions, cooking daily, and electric power for a good deal of the cleaning work.

Here we get a set of conditions which, if put fairly before the architect when drawing his plans, enable him to reduce the first cost of the building and also give him a great deal more freedom in designing.

The gas suppliers in connection with housing schemes have already pointed out the considerable saving which they can effect by the wider use of gas and by the provision of small flues within the brickwork of the walls in place of the usual full-size chimneys.

We can go much further than that, cutting out flues altogether, and leaving the full space of the room available, dispensing with fenders and fireplace furnishings, and at the same time allowing the occupant the use of inlet and outlet ventilators at the floor and ceiling of the room, which gives him more control over the air supply than is possible with the usual ventilation through the fireplace or gas stove.

ELECTRO-FARMING AND ITS FUTURE.

By R. BORLASE MATTHEWS, A.M.Inst.C.E., M.I.E.E., F.R.Ae.S.

When the goddess of fruitful harvests, Demeter, smiled upon Persephone, her daughter, the fruit ripened and the corn grew twice as quickly as at any other time. In this more utilitarian age, people look for aid to something more tangible than a mythological goddess, if they want to make two blades of grass grow where one grew before. It is to electricity that the farmer will have to turn during the coming decades, whether he desires merely to continue farming or wishes to wrest from the soil a living as good as, or better than, if he had followed any other walk of life. At the present time it would seem that a pretty healthy imagination is required on the part of most folk to visualise the agriculturist employing electricity to any extent. Engineers at any rate ought to have a good imagination, so this change in methods in the world's oldest—and still the largest—industry ought to be more easily assimilated by them than by the ordinary man-in-the-street. Talking of imagination reminds the present writer, who had the privilege of being one of Professor Perry's students, of the great stress that that gentleman laid upon the need for imagination as a most important part of an engineer's education. In the quaint way familiar to those who knew him, he pointed out how necessary it was for an engineer to read novels—of course, good ones—to help to train his imagination. To this end he insisted upon each of his students—who were apt to get far too engrossed in their technical studies—reading at least two novels per term. In order that there might be no excuses, he even provided a library of novels for the purpose. Since the readers of this article are obviously gifted with healthy imaginations (or else they would not be perusing this journal), the task of discussing with them the possibilities of the future of electro-farming will not be difficult.

There is something very fascinating in probing into the future. It is one of the great human weaknesses, as is evidenced by the large army of palmists, phrenologists, crystal gazers, fortune tellers, and the like. So when those mysterious plural personages, "The Editors" of the Electrical Review, asked the author to write a few notes on the future of electric farming, he said that apart from prophecy being a dangerous matter, it would be a very interesting task, though more in accord with the work of such masters of the scientific futurist novel as H. G. Wells or Jules Verne, or even old Moore of Almanac fame. However, "The Editors" very kindly pointed out that most people in course of time forgot a prophet's faulty prognostications and only remembered his successes. (It is to be presumed that when time proves a modern prophet to have scored a success, he nowadays gets his Press Agency to hammer the good news well home.) Though prevailed upon to act the amateur prophet, the writer does not propose to take too many liberties or too many risks. Experience has shown him that no future development comes eventually into continued existence, unless it is based upon sound scientific and mechanical principles. So few people have turned their imaginations to the possibilities of electro-farming that it is commonly regarded as an insignificant matter. They are, however, apt to sit up and take a little notice, when their attention is drawn to the fact that to-day, in this most industrial age, there are more men engaged upon agriculture than in any other single occupation in this world. Now if almost every other industry has taken considerable advantage of electricity, it does not take a prophet of much standing to prognosticate that one day farmers as a class will follow the example of other industrialists.

In the past, farming, on the whole, has not been

treated very seriously. Generation after generation of farmers has been contented to jog along on the lines of their forbears. And this perhaps is not to be wondered at, when the penalty of departing from precedent is apt to be so great, in the form of the loss of crops off many acres, or the loss of valuable stock. Again, the farmer has always been favoured with cheap (or seemingly cheap) labour—and it is well known that there is no deterrent to progress so great as cheap labour in industry. A farm is not like a factory, for the turnover is regulated by seasonal laws of Nature which cannot be modified to ny really appreciable extent. The nearest simile in electrical work is that of the central electricity supply stations. These undertakings can never provide extraordinarily big profits, because the conditions of their service are such that they cannot turn their capital over often enough.

Another obstacle in the way of the electrification of farms is that there are, as yet, very few places where suitable electrical apparatus can be purchased. So far, the electrical engineer has not co-operated to any serious extent with the agriculturist. Thus, if a progressive farmer wished to-day to equip his farm electrically, he would have very great difficulty in doing so effectually, efficiently, and economically.

However, it is the business of this article to talk of the future, when of course these pioneer difficulties will have been swept away.

Farming a few decades hence will be very different from what it is to-day. Then as much will be known by farmers of the bacteriological and chemical conditions of the soil as is known by engineers to-day about the complex nature of steels. Electrochemical treatment of soils and electrochemical manures (to-day in their experimental stages) will be employed as a matter of course. The farmer is a notorious grumbler about the weather and most other things. In the near future, weather will have less and less effect upon his success, for he will be able to circumvent the weather by carrying out his work in spite of it. Illustrations of this are the making of hay and curing of sheaves of corn, in the actual ricks, instead of out in the fields. (This work is already being carried out on a full-size commercial scale on the author's farm.) By such methods the work can be performed, regardless of weather conditions, directly the crops of grasses or corn are developed or ripe enough to cut. Again, these crops will themselves be made to come to maturity in a minimum of time, and with a maximum of yield, by means of electrical treatment. (Already, to-day, 10 per cent. increase can be anticipated, with a possible gamble on a 50 per cent. increase.) Of course, the germination of the seeds will have been started in an electrolytic bath, so that when the process is carried further in the soil, a better plant and better fruit is obtained, which desirable result is further pushed on by the electric treatment. This electric treatment will, of course, be regulated in accordance with the weather. Under adverse weather conditions considerable use will be made of it, so that crops may not be set back, but will rather be caused to develop normally, in spite of the weather.

Prior to the sowing of the seed by means of electrically-operated drills, the cultivation will have been carried out by the aid of electric power. Naturally the crude plough of to-day, with its brute force method of attack on the earth, will have given way to electrically-operated implements on the principle of the engineer's milling machine (the precursors of these machines are already in existence). The cutting or working points of these tools will be so shaped and set as to operate on the earth at a maximum efficiency. Just as easily as metal cuttings flow away at the point of a high-speed steel tool, so will the earth particles flow away on the cutting points of the agricultural "ploughing" machine of the future—and the lubricant for the agricultural tool will be a discharge of electricity. (Already it has been discovered that an electrical leak on to a plough share facilitates its passage through the earth.)

After the preliminary "milling" of the soil, it will have to undergo an electric sterilisation treatment prior to the introduction of fresh families of the best types of bacteria most suitable for the particular crops to be grown. Electrolytic manures will also be introduced and mixed at the same time, until the whole field is the absolutely ideal life-giving material for the plants to be raised. Many fields will have permanent concrete bottoms laid a couple of feet under the surface, to prevent the stones and subsoil working up, and so altering the composition of the carefully prepared soil above. In seasons of drought, water would be sprayed over the crops at night by the aid of electrically-operated pumps, and automatic travelling suspended pipe lines.

Photo by [*Elliott & Fry.*

R. Borlase Matthews.

Just as the cultivation would be carried out by electrically-operated implements, so the reaping and harvesting implements would be similarly worked. In both cases, the machines will be electrically hauled over the soft ground by the aid of steel ropes. Some of these steel ropes will be provided with insulated copper cores to carry the current for operating electric motors on the implements, or from the master controllers on the moving implements to operate stationary electric haulage sets at the sides of the fields. Hedges between fields will have disappeared. Even now their maintenance is too costly; then the land will be too valuable. In the future, fences will not be required for the purpose of keeping live stock within bounds, for all stock feeding will be carried out in stables or stalls; yards adjoining will provide for daily exercise.

The feeding of the animals and the preparation of their food, the milking of cows, &c., will all be carried out by electromechanical methods. The necessary raw materials will be delivered at one end of the farm buildings, by means of a light electric railroad from the nearest main-line railway station; or from the farm itself, by the farm light electric railway to the same end of the buildings. All the machines, conveyors, &c., will be driven by direct-connected electric motors of one-third the weight and cost of present-day motors. At the same time the revolutions per minute will only be 60 to 150, to accord with the speed of the machines they drive. (A couple of these novel motors are already in existence in the author's farm experimental engineering workshop.)

A feature of the electric farm motors of the future will be their extreme robustness and simplicity. In-

fact, all farm machinery in these coming days will be so designed as not to harbour dust, or be affected by falling dirt or rain. Every part of the equipment will be all of the absolutely fool-proof, press-the-button-and-we-do-the-rest type.

The main distribution of the electric current will be by means of bare overhead wires. Sub-circuits will be led off by means of special, easily fixed connections, through overhead straining block fuses, to those places

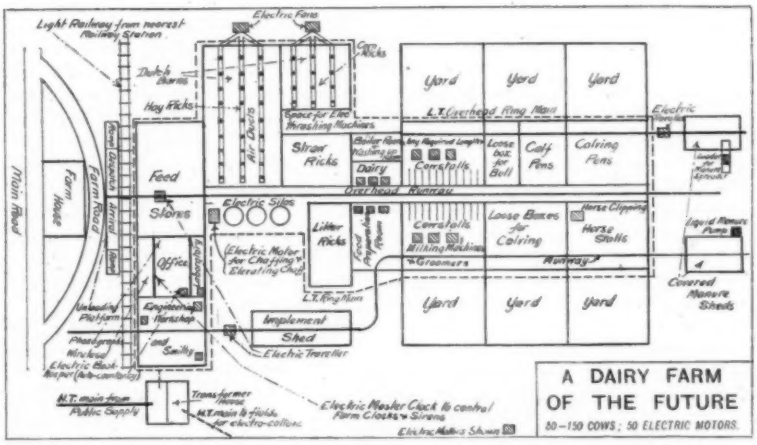


Fig. 1.—A Dairy Farm of the Future.

where electricity is required for use. The internal wiring will be carried out in toughened, protecting-sheathed wire—acid, alkali, and vermin proof. Screwless fittings (which automatically fix themselves when pressed against the bared wire) will be employed (these are already in existence on the author's farm), for in that day and generation, people will not be bothered with small fiddling screws or the high cost of labour for connecting the fittings of to-day to the circuit wires.

Water heating and the heating of foods will be carried out electrically by means of heat storage devices which use current in the off-peak hours.

The lay-out of the farm buildings will be designed by efficiency engineers. The average size of each farm will be much greater than it is to-day. Specialisation in products will also be a prominent feature, for the ultimate success of any business, farming included, depends upon the ability to carry it on in a better way, in some aspect, than any similar existing business. The intelligence of farm hands will be greatly increased, and likewise their wages. In fact, the skilled mechanic will be able to return to the land, for there he will find a good opening and a healthy life awaiting him.

In conjunction with the farm of the future, various seasonal rural industries will be incorporated. The nature of these industries will be such that they will lend themselves to winter work, and save the transport from the farm of products and by-products eventually needed on the farm. In this way, the load factor of each rural district will be maintained at an attractive figure. After all, farm loads cannot be considered in the isolated sense by the central-station engineer, because developments of the use of electricity on the farm itself will lead to developments in the surrounding district.

Of course, in the future, no farmer will think of obtaining a supply of electricity except from a central station. The central-station engineer of to-day is shy of the rural supply. He certainly must continue to be so, as long as he does not do his share in assisting the farmer by showing him how he can use electricity in agriculture. It is usual to say that the farmer is very conservative, and also that he has no money. Now, the successful farmer does not like the outsider to know what are his profits. But just watch him when he goes to a pedigree cattle sale: a recent sale of this nature averaged £1,100 each for 100 beasts, one or two selling at about £3,000 a head. A present-day tractor with a suitable plough and other equipment makes a hole in £500—there are now over 20,000 tractors in use in this country. A thrashing machine averages £500, and there are thousands in use. In good times a manufacturer will turn out 30 or so a week. Recently a German firm's output of electric ploughs, averaging £1,200 each in value, was 160 in one week. Hence the farmer to-day, in the aggregate, is finding huge sums of money for things which he knows will return him a profit. It is therefore easy to deduce that he will find the finance just as readily for electricity when he is convinced of its merits. But to assist him in this direction he needs co-operation on the part of the electrical engineer.

If every farm in this country were provided with the average electrical equipment of the best Continental farms and that of the author's farm, the energy supplied for farming alone in this country would far exceed the total consumed to-day for *all* other purposes. But the big electro-farming developments have still to come, as has been suggested above. This gives one furiously to think (to translate literally a French idiom). The whole question of electro-farming is already far more than well-worthy of consideration to-day; it should be vigorously and intelligently pursued.

In 1908 the present author contributed a series of notes on the commercial development of electricity supply undertakings to the columns of the Electrical Review. Therein he summarised his experience (gained prior to that date) that the best way to increase the load on a central-station supply system was by educating the public as to the possible applications of electricity in their homes and businesses. Looking back to that date, and observing the progress that has been made in central-station supply in the intervening period, it must be realised that many of the proposals then discussed have since been put into practice. There has been, however, far too much dependence upon Father Time. The magnitude of the potential—though at that time generally unappreciated—demand is reflected in the large generating sets which are nowadays as standardised as the 500-kW and 1,000-kW sets of a decade ago. The education of the consumer has made them necessary.

Fig. 2.—The Farmer's Method of the Future.
Testing the temperature whilst curing hay the electric way—without sunshine—on Greater Felcourt Farm, East Grinstead.

Given sufficient time, electro-farming will develop to an even greater extent. But by following the self-same principles of education and co-operation, the development can be encompassed in a very few years from now. The choice of slow or rapid development lies in the hands of the central-station engineers.

THE PRESENT AND THE FUTURE OF THE ELECTRIC VEHICLE.

By F. AYTON, M.I.E.E.

Up to the present the demand for electric vehicles in this country has come mainly from municipalities for use in connection with the work of refuse collection. Electrics, in considerable numbers, are to-day employed for this purpose, and it can be asserted that, in practically every instance, they have demonstrated their superior economy and other advantages as compared with the alternative methods of collection, so much so, indeed, that cities like Glasgow, Birmingham, and Sheffield have gradually acquired fleets of significant proportions. The electric vehicle has also proved highly economical and useful in other departments of municipal service, *e.g.*, street watering, cartage of road material, gully emptying and cleansing, general carting, emergency service in connection with electric supply departments, tramways, and also for ambulance duty. Those who are aware how effectively the electric has made good in this sphere of utility can have little doubt, if any, that its employment is likely greatly to increase in the near future, for in the particular uses referred to, economy and reliability are cardinal desiderata.

While the adoption of electric vehicles for urban and suburban transport by manufacturers, merchants, tradesmen, and the like has not progressed to the same extent as it has in the case of municipalities, it is nevertheless the case that there are many firms using electrics and not a few possess fair-sized fleets, as, for example, Harrods, Selfridges, Boots, Whiteleys, Hay's Wharf Cartage Co., and many others, including several large breweries. There is also the example of the large railway companies—the Midland (with close upon 100 vehicles), the Great Western, Great Eastern, and others. There can be no question that electrics are used by business houses and by railway companies to the extent they are, solely because, for the special services in which they are employed, they offer the most economical and reliable form of transport. One can safely assert that the same considerations have guided local authorities in their selection of this type of motor vehicle for certain classes of work.

That the adoption of the electric vehicle has not made greater progress since the termination of the war is, in the main, to be ascribed to two causes: First, the large numbers of re-conditioned Government petrol vehicles which have been disposed of at low prices, and this during a time when, due to abnormal wages and cost of materials, the prices at which electric vehicles could be purchased were comparatively high; and, secondly, the lack of adequate charging facilities in different towns and cities.

The British-built electric can be bought to-day at about half the price which had to be charged for it in 1920 and 1921. It has frequently been asserted that the prices quoted for British-built electric vehicles were too high, and the suggestion has been made that they included an inordinate amount of profit. As an answer to this totally erroneous view, it may be stated, as an incontrovertible fact, that, in this post-war period, no British firm building electric vehicles has made any profit worth speaking of—indeed, it would be safe to say that most, if not all of them, have made losses on the business done. I would ask those who are so ready to assert that the first cost of the electric is too high to bear in mind (1) that, if the demand for this type was to any extent comparable with that for petrol vehicles, the manufacturing costs could undoubtedly be reduced and consequently the selling price, but at present the demand, by comparison, is small, and consequently production upon a similar basis is out of the question; (2) that the useful life of the vehicle is at least double that of the petrol vehicle, and the operating cost, under equal conditions, appreciably lower after allowing for interest on outlay, depreciation, &c. Consequently, at the much reduced and very moderate initial cost of the electric vehicle ruling at the present time, it is one of the best possible investments where short-distance haulage is concerned.

Owing to the enterprise of certain electricity supply undertakings, properly-equipped charging stations are in existence in a few cities and towns, but there yet remains much to be done by electricity supply authorities in providing such facilities before any considerable expansion can be expected in the use of electric road vehicles by the commercial community. It is to be hoped that those responsible for the management of electricity supply undertakings, now that they have got over most of the difficulties resulting from the war, will see their way actively to encourage the employment of electric vehicles, not only by the adoption of a reasonable tariff, which is very necessary, but by laying out the comparatively small amount of money required to provide permanent battery-charging service.

I can assert, from my past experience as a supply station manager, that the demand for energy for vehicle battery charging is well worth taking some trouble to cultivate. It can be made an off-peak load—a night-time demand occurring when the ordinary power user is not taking a supply and the winter evening lighting peak is well on the wane. It should be possible, in the case of most undertakings, to make this particular business a remunerative one by a charge for electrical energy of not more than 2d. per unit, metered into the battery at the correct voltage; a few undertakings, I understand, are now charging less than 2d.

There can be little hope, generally speaking, of getting electric vehicles adopted by business people, unless the local supply authority first of all puts itself in a position to give battery-charging service. It is seldom that a firm employing road transport for town work can be induced to make a trial of an electric vehicle if it necessitates the installation of charging plant. Once, however, a firm has made such a trial, it is usually the case that it is so convinced of the economy, reliability, and other advantages possessed by the "electric," that it proceeds to order more electric vehicles, and then, most likely, installs its own charging plant. Where public charging facilities exist in the locality, it is usually not difficult to persuade a firm to order a trial vehicle and then, of course, the electricity supply undertaking benefits by securing a further outlet for those profitable off-peak units. But this must be remembered by those in charge of supply undertakings who are anxious to cultivate this class of demand: facilities, more or less permanent, and most certainly adequate, must be provided before any demand can, in most cases, be expected. I am aware that there are cases where the supply authority has difficulty in providing charging facilities for want of space on which to erect a building in which the vehicles can stand during the night—the time during which charging is carried out. A covered place is certainly necessary for this purpose, and, for this provision, it is only reasonable that a garage fee be imposed upon the vehicle owner in addition to the charge per unit for the energy supplied. In Ipswich, for example, the garage charge is 16s. per vehicle per week, which is additional to the charges made for electrical energy (2d. per unit), supplying distilled water to the battery, cleaning, &c.

When it is not feasible for the supply authority itself to provide the charging station, it ought not to be a matter of difficulty to arrange with a local motor garage proprietor or an electrical contractor to provide such facilities, the authority loaning him the necessary motor-generator and switchgear at a merely nominal rental which, starting at almost nil, would rise, as the charging business grew, to a reasonable figure, the charge for energy being fixed at a specially low figure, so that, allowing for losses in conversion, it might be possible for the proprietor or contractor, as the case might be, to

secure a fair and sufficiently encouraging profit on the units used. In most cases it would, no doubt, be necessary to subsidise the firm during the early stages of building up the battery-charging business, and this would not seem unreasonable, having regard to the fact that it is very rarely that a business in a new line can be built up without a loss being made in the first year or so. To have electric vehicles running in any town is a very good advertisement for the electricity supply undertaking. Whether the charging service be provided by the supply authority, or indirectly, by the alternative just mentioned, it is essential that the staff of the supply department be willing and competent, in the early stages at least, to give advice upon the proper methods to pursue in the charging and maintenance of batteries. It is upon the sort of attention given to these matters that the success or failure of the electric vehicle depends. It is a simple matter for anyone with electrical training to become capable of giving such advice.

Up to now the limited radius of action of the electric, due to battery capacity in relation to battery weight, has made it the competitor of the petrol vehicle only when the latter is employed on service which comes within the sphere of the former. Actually, the main competitive form of transport in that sphere is horse haulage. Horse haulage is, however, rapidly being displaced by motor haulage in our large towns and cities. At the moment the substitution is by petrol much more than by electric vehicles, and at an operating cost considerably in excess of what it would be if the last-mentioned type were more generally employed.

No doubt the recent reductions in the cost of motor spirit will tend towards helping the further adoption of petrol vehicles for urban transport. Those, however, who are in a position to form a judgment upon the matter, know quite well that there cannot be any stability with regard to the prices of petrol, and that they are certain to rise again with any general revival of the world's trade. The oil resources of the world are limited, and it is a fact that, until the trade slump came, the demand for petrol was actually increasing at a much greater rate than new sources of production were being revealed.

It is noteworthy that, at the International Liquid Fuel Congress held in Paris a few weeks ago, M. Daniel Berthelot uttered a warning in regard to the world's petrol supplies. At the present rate of consumption he estimated that they would be all exhausted at no very distant date. He remarked: "The generation which has seen the rise of the petrol industry may yet see its fall." Another authority upon the subject, Prof. W. S. Boulton, in a recent address delivered in Birmingham, expressed the belief that "the natural oil age would be very transient." A shortage of petrol would therefore appear to be fairly certain in the near future, with consequently soaring prices. Such an eventuality is bound to have effect in extending the employment of electric vehicles, especially when one considers that the cost of electrical energy will, in all probability, continue to decrease.

So far as the chassis, motors, and transmission are concerned, the design of the modern type of electric has reached a stage in which no startling change would appear likely in the next few years. Where improvement may very probably take place will be in respect of batteries, though it must be said that present designs of lead-plate and nickel-iron-oxide accumulators, as supplied by well-known makers, give very satisfactory service.

There are good reasons for predicting the employment of electric vehicles upon a considerable scale in the near future. It will, no doubt, be mainly in urban areas, but any improvement upon the present types of battery in the direction of increased capacity per unit of weight will widen the field of utility, and if, concomitantly with such improvement, we come to the establishment of the battery exchange system and sufficiently numerous exchange stations, it will undoubtedly lead to electrics being employed in rural or long-distance transport. With the improvement which is continuously in progress in road construction we may very likely see the electric entering this wider field of employment at no very distant date.

The immediate expansion, however, will be for urban and suburban delivery service. The horse is gradually being eliminated in this work, and the petrol vehicle will be found too expensive as his substitute. Gas-producer internal-combustion engine lorries may have a certain vogue, but it is doubtful whether, on account of the fumes emitted, they would be permitted, on any considerable scale, in towns and cities. Users of transport will eventually be forced to the use of electric vehicles on the score of economy in operating cost alone. A comparatively enormous field for development exists in connection with haulage and transport in our urban areas, and I look forward, with confidence, to also seeing large numbers of electric vehicles employed within the next few years in taxicab and private car work—it is something which is bound to come.

Frank Ayton.

Any consideration of the present position and the future of the electric vehicle must necessarily include a reference to electric trucks, those wonderfully useful and handy little vehicles, the employment of which has resulted in large savings in handling expense to the now considerable number of firms employing them. Their use is extending at a far greater rate than is the case with the road vehicle, and it will not be long before those who adhere to the hand-barrow method of moving goods and materials in and about factories, warehouses, railway terminals, docks, &c., will be looked upon as hopelessly out of date.

Battery Charging.—A new method of charging batteries for electric vehicles is described in the *Electric Vehicle*, which is claimed to reduce the initial outlay on charging equipment and also to obviate loss of power. A 5-wire balancer is used; unlike the motor-generator, it does not have to transform the total energy consumed, but deals only with a small fraction thereof. When the load is balanced, it simply runs idle across the 440-V mains and takes little power, but is continually on the *qui vive* to see that no one leg of the 5-wire circuit gets a higher pressure than 110 V.

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THE FUTURE OF RAILWAY ELECTRIFICATION AND ITS CONNECTION WITH POWER SUPPLY AND DISTRIBUTION.

By SIR PHILIP DAWSON, K.B.E., M.Inst.C.E., M.I.E.E., M.I.Mech.E.

The electrification of main-line railways has been practically at a standstill in Great Britain since the last years of the war. Although the electrification of the North-Eastern between York and Manchester and that of the Brighton Railway between London and Brighton has been discussed, no active steps have as yet been taken to carry them into effect.

Not so on the Continent of Europe, more especially in Central Europe, and it may prove a surprise to some people to find that the mileage of electrified main lines operated by electric locomotives is 3,240 miles on the Continent of Europe as compared with 2,030 miles in the United States, and that there are in round figures some 1,100 electric locomotives either running or nearing completion, in Europe, as compared with some 350 in the United States.

So far as Great Britain is concerned, electrification has taken place more especially in the case of purely urban railways operated by multiple-unit stock.

Tables I and II give a general idea of the work so far carried out or in process of completion in connection with main-line electrification.

It is not only in districts where water power is available and coal scarce that such works have been carried out, although this was the condition which was largely responsible for the electrification of the Swiss, Italian, Bavarian, and Austrian State railways.

Thus in the case of Prussia, the 110 miles of route between Magdeburg, Leipzig, and Halle is supplied with energy from a steam-driven station located on a brown-coal field which at present furnishes energy to the 62 electric locomotives required for the operation of this section of line. In Silesia, in the neighbourhood of Breslau, between Lauban, Königszelt and Görlitz, lines comprising 165 miles of route, and on which 77 electric locomotives are in service, are operated entirely electrically, and are supplied with current from a generating station on a black-coal field.

Table I.

Country.	Miles of track electrified or being electrified.	Elec. locos. running or on order.
Germany	800	288
Austria	500	82
Switzerland	500	154
Switzerland, narrow gauge ...	160	21
Sweden	280	47
Total, single-phase ...	2,240	792
Italy, three-phase	500	150
U.S.A., single-phase	630	126
U.S.A., d.c.	1,400	213
France, d.c. (under construction and projected)	500	138

Whereas France and Holland have decided to adopt 1,500 volts d.c. as the standard for electrification, Germany, Austria, Switzerland and Sweden have definitely adopted the single-phase system of traction for the whole of their railways, with a line pressure of 16,000 to 17,500 volts and a frequency of 16⅔ periods. Italy has also adopted alternating current on a large scale in the form of 3-phase current at a line pressure of 3,000 volts and a frequency of 15 periods.

Table II.

Summary.	Miles equipped or being equipped.	Electric cars running or on order.
Europe, single-phase	2,240	792
U.S.A., single-phase	630	126
Total, single-phase ...	2,870	918
Europe, three-phase	500	150
Europe, d.c.	500	138
U.S.A., d.c.	1,400	213
Total d.c. (carried out and under construction)	1,900	351

Photo by] [Greenslade.

Sir Philip Dawson.

It is interesting to note that Mr. Kolman von Kando, who originally installed the three-phase system on the Valtellina line between Lecco and Sondrio in 1900, and later acted as adviser to the Italian Westinghouse Co. at Vado Ligure, near Savona (now taken over by Brown, Boveri), is at present working on a split-phase locomotive which will collect current from a single-phase overhead conductor, although three-phase motors with a pole-changing device and operating in concatenation will actually propel the locomotives.

A further development which may very largely influence railway electrification is the Lenz gear, now undergoing successful tests in Germany. It is very efficient and simple, and does away with all mechanical gearing. Its use would enable synchronous single-phase motors to be used operating at 50 periods off a single-phase line.

The tendency so far in Central Europe has been to generate the current required for single-phase railways directly as single-phase current of low periodicity, both in steam and hydro-electric stations. The same thing holds good of the low-periodicity three-phase current required by the Italian State Railways.

The Swiss engineers strongly contend that under any circumstances, no matter what system of electric traction is adopted, the railway supply and the general supply should always be kept entirely distinct.

In the United States, on the other hand, whilst some single-phase as well as d.c. railways have their own generating plant, and whilst in some cases single-phase current is generated as such, there are many other examples of both d.c. and single-phase traction where the current for traction purposes is taken from a common supply station.

The conclusions arrived at in the report on a super-power system proposed for the region between Boston and Washington are all in favour of a joint supply for all purposes, including railway electrification, and similar conclusions have been arrived at in this country. With the spread of large networks of high-pressure transmission lines, such as are now rapidly being in-

stalled all over Central Europe, and more particularly in Germany, it is practically certain that for all the large extensions of railway electrification now contemplated and under discussion, the railway supply will be furnished from stations serving all demands.

The great spread of railway electrification in Central Europe is the direct result of the rise in the cost of fuel, the rise in wages, and the eight-hour day. These factors have upset all previous conditions of railway operation, and greatly increased the already considerable benefits to be derived from electrification.

Railway electrification in its turn will bring electric power within the reach of all, and into districts which otherwise could not have benefited by it. The farmer in Germany and Switzerland has not been slow to appreciate the benefits to be derived from the use of electricity, and it is true to say that there are few villages or farms in Germany to-day where electricity is not in general use for thrashing and many other agricultural purposes, as well as for lighting, and this even in the areas where coal is plentiful.

Germany, both during and since the war, has developed extraordinarily both the generation and transmission of electric power, and some of the more recent capital stations established in that country are given in Table III. It will be seen that there are various

TABLE III.

	Output in millions of kWh.	Plant installed in thousands of kW.	Plant on order or under c'nst'ction.	
Zschornevitz (Saxony) ...	754	128	15	BC
Trattendorf ,, ...		20	135	
Rheinisch Westfalische Elektrizitätswerke	749	112	362	C
				BC
Cologne Kraftwerk Fortuna	156	40	32	BC
Borkum Elektrizitätswerk Westfalen	172	44	10	C
Elektrizitätswerk Hagen, Westfalen	103	36	12.5	C
Hirschfelde (Saxony) ...	66	40	20	BC
Berlin City Electricity Works	198	195	—	C
Oberschlesischer Industriebezirk	405	84	—	C
Laufenburg (Switzerland) ...	309	50	—	W
Augst ,, ...	91	17	—	W
Walchernsee (Bavaria) (nearing completion)	—	110	—	W

B, brown coal; C, black coal; W, water power.

groups of large new super-power stations, some built on the brown-coal fields near Cologne and on the brown-coal fields of Saxony, and others operating on black-coal fields or worked by water power.

Thus at Cologne there are several stations located on the brown-coal fields, one belonging to the Stinnes interests (Rheinisch Westfälische Elektrizitätswerke) with one station, including three 60,000-kW sets, each comprising one turbo-alternator and one transformer, another the Fortuna Works, and one belonging to the municipality of Cologne with 16,000-kW sets. Then there are the two large stations of Zschornevitz and Trattendorf, located on the Saxon brown-coal fields, which transmit at 100,000 volts to Berlin nearly 100 miles distant with sets of 22,500 kW and 45,000 kW respectively, and the station of the Saxon Government with 20,000-kW sets; in addition there are the railway generating stations near Bitterfeld on the brown-coal fields supplying the Magdeburg-Halle-Leipzig line and the station in Silesia, near Galatz, on the black-coal fields supplying the electrified sections of the State railways near Breslau between Lauban and Königszelt. Further, there are several stations located on the black coal of the Ruhr and Westphalia connected up with waste-heat stations.

There are, in addition, the large hydro-electric plants now being installed in Bavaria, which will shortly be completed. Most of these stations are, or are being, interconnected with a 110,000-volt transmission line, which will shortly cover the whole country and interconnect the brown-coal fields of Cologne and the black-coal fields of the Ruhr and Westphalia, with Hanover and Berlin on the one hand and with the hydro-electric plants of Bavaria and the Rhine on the other.

The brown-coal fields of Central Saxony are connected up with Berlin on the one hand and with the brown-coal fields near Dresden, the black-coal fields of Silesia and the water powers of Bavaria and the Rhine on the other.

There exists already a very extended network of high-pressure transmission lines all over the country which are, or will be, connected up with the main trunk 110,000-volt transmission system. How completely Germany is equipped with super-station transmission and interconnecting lines is shown in the map specially prepared for this article (p. 744).

If we examine the map of Central Europe in the light of the German progress of electrification, we see that it cannot be very long before the main-line railways between Berlin and Breslau will all be electrically operated. The financial results already obtained on the electrified lines are sufficient to warrant this anticipation, and plans for such extensions are either complete or in process of being completed. The same thing holds good as regards the lines connecting Breslau and Munich, which will link up the lines already electrified in Silesia with those of Bavaria. The whole of the Swiss Federal railways are now in process of electrification, and it will not be many years before the steam locomotive has entirely disappeared in Switzerland. In Czecho-Slovakia, too, great schemes are in hand to develop the water power and the brown and black-coal fields, and simultaneously to electrify considerable portions of the State railway. At no distant date we can therefore look forward to trains entirely operated electrically running from Berlin to Breslau, to Munich and Vienna, and from Vienna to Munich, Vienna *via* Innsbruck to Basle and Basle to Milan, Genoa, Ventimiglia and Pisa.

It will be noted that whilst water power will generate the current for the Austrian, Bavarian, Swiss, Swedish and Italian railways, it will be brown and black coal which will be utilised in the case of the Prussian and Silesian lines; whilst a combination of hydro-electric and brown-coal stations will be utilised in the case of the Czecho-Slovakian lines.

Although the low periodicity of 16 periods has been adopted for single-phase railways on the Continent of Europe, 25 periods has been quite successfully adopted, and on a very large scale, in the United States as well as on the Brighton Railway.

It is interesting to note that since the war, in Germany, Austria, Switzerland and Italy the policy of the Governments has been to encourage and proceed with the electrification of large portions of their railway systems, as well as with the construction of the necessary thermal and hydro-electric power plants and transmission lines, and with the building of the large number of electric locomotives required therefor. This has usefully employed a large number of skilled men, who but for this would have been without work. The contrary policy has been adopted in this country, where since the war electrification has been practically at a standstill, and largely owing to political causes and to the late Government's apathy may remain so for a long time to come.

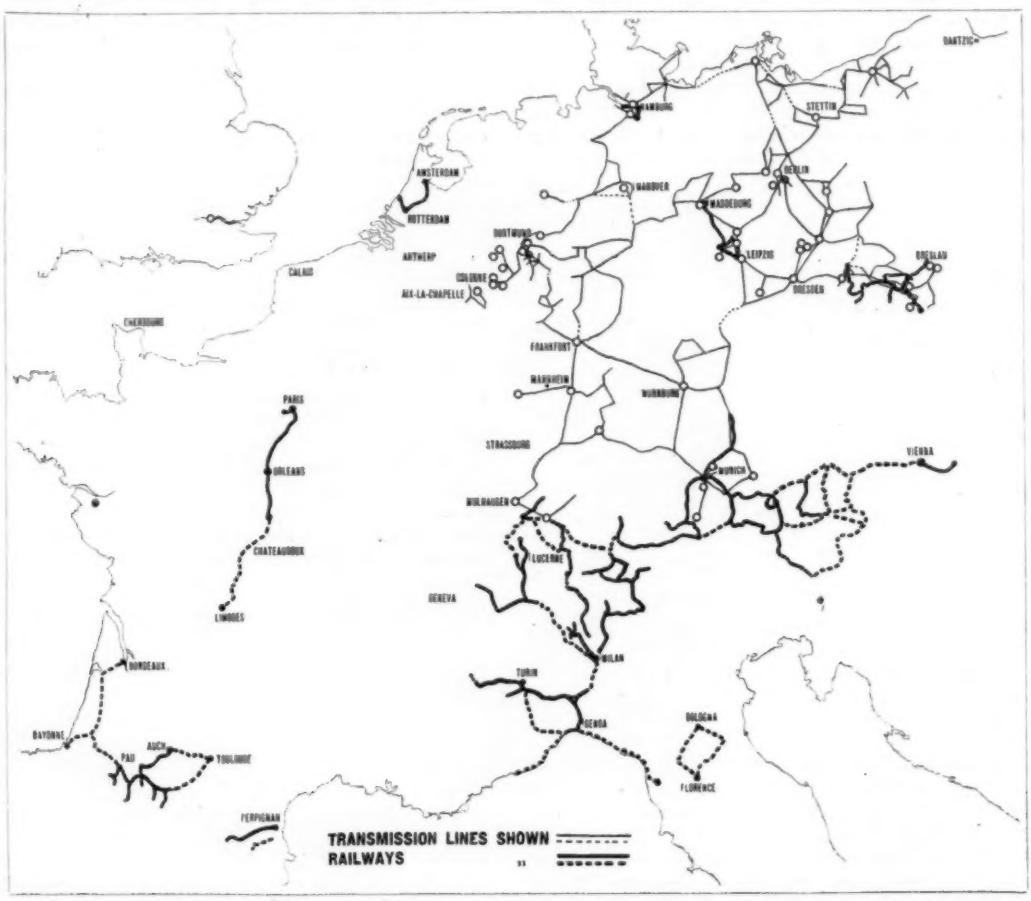
The electrification so far carried out in this country has proved of great benefit to the travelling public, and has been most satisfactory to the shareholders, a fact fully admitted and stated over and over again by the chairmen and general managers of our railways. It has been shown that even with the increased cost of labour and materials, the electrification of such systems as the suburban system of the South-Eastern, the suburban and main-line system to Brighton of the L.B. & S.C. Railway Co., and the suburban system of the Great Eastern would result in a return of from 10 to 18 per cent. on the capital expenditure involved thereby. The above electrifications would at once render not only possible but necessary the erection of two capital stations in the London electricity area which would materially assist in the supply of more abundant and cheaper electricity for all purposes, and which having regard to this large output and satisfactory load factor could be operated at a profit, and show a handsome return on the large capital expenditure involved.

The preceding schemes have been thoroughly and completely investigated, so that had a decision to carry them out been arrived at, orders for a large portion, even if not for the whole, of the work involved could have been placed at once and would have given occupation to skilled workmen in all parts of the country. There would have been no difficulty in so dividing the various orders as to furnish work to a large number of manufacturers of locomotives, rolling stock, electrical equipment, boilers, piping, pumps, and accessories, coal and ash-handling plant, steam turbines, electrical plant and apparatus of all kinds, cables, rails, structural steel work, cement, &c., &c., all over the country, just at a time when our manufacturers are most in need of orders to keep their works going. But for reasons, the real cause of which it is difficult to get any satisfactory explanation for, the wise policy pursued in other countries of assisting to carry out work which would have been of the greatest benefit to the travelling public, would have brought practically an immediate return on the capital expenditure, and would have given employment to tens of thousands of skilled British workers, has not found favour.

There are other equally sound and attractive electrification schemes, some of them sufficiently advanced to enable them to be taken in hand at once, such as the electrification of the North-Eastern Railway main line from York to Newcastle. Others not quite so advanced, such as the electrification of the lines round Liverpool, Manchester, Leeds, Bradford, Glasgow, and the South Wales coalfields, to name but a few instances, could be looked into with a view to enabling work on them to be taken in hand at no distant date.

There is another case in connection with which an investigation as to the possible benefits which might be derived from electrification should be undertaken. The Water Power Resources Committee of the Board of Trade, in a recent report, referred to several water powers in the North of Scotland which might be well worth developing if an immediate sale could be found for a part, if not for the whole, of their output, and it is quite conceivable that the development of some of these might, in conjunction with the electrification of certain portions of the railways in the Highlands, prove an attractive proposition.

There are several examples in Central Europe where the study of railway electrification has been carried out in conjunction with proposals for new and improved waterways, the construction of which is dependent on utilising successfully the water power resulting therefrom. The most important of these schemes which has reached the stage of commencing to be realised is what is known as the Main Danube Canal, the financial success of which was to be brought about by disposing of the electrical energy produced by the hydro-electric plant erected along the banks of the canal. The scheme was thoroughly investigated by a commission appointed by a "Studien Gesellschaft" created in 1917, representing the various German States, the German Government, the large cities through which the canal had to pass, and the large industrial and financial groups. The result of this very thorough investigation showed that the interest on the whole capital required for the construction of the canal and the hydro-electric stations would be provided by the profit made out of the electricity supply, and that the receipts from shipping passing through the canal would be additional profit.



Map of Central Europe, showing Electric Railways and Main Transmission Lines, Completed and Projected.

The above scheme is the only one on which work has actually been started, but there are others, such as the canalisation of the Neckar in Wurtemberg and the Elb-Danube canal in Czecho-Slovakia, which have been carefully and fully worked out and which would incidentally enable a considerable amount of hydro-electric power to be developed.

The schemes referred to are similar to the project elaborated before the war by Siemens-Schuckert and the A.E.G. in Russia, whereby these firms secured the concession for canalising the Dnieper, which, when completed, would have enabled large craft to go from the Baltic to the Black Sea, and, incidentally, would have enabled hydro-electric power of over 250,000 h.p. to be developed, all of which would have been easily disposed of in the Donetz iron and coal regions.

France is proceeding with the electrification of her main lines, such as that now in process of realisation by the Orleans and Midi Railways, and is utilising and developing for this purpose the water powers to be found in Central France, on the Rhone, and in the Pyrenees. Incidentally, this will result in a transmission system in France such as exists in Germany, interconnected with the large steam super-stations recently completed in Paris and in the Lens district.

In Spain important main-line railway electrification schemes are under consideration. Holland and Belgium have also main-line electrifications projected or in course of realisation, which will depend for the supply of their electrical energy on thermo-electric stations.

Experience has shown that whilst in mining and industrial areas railway electrification may be an accessory to the installation of super-power stations, the contrary will generally be the case in non-industrial districts where the electrification of railways will dominate the situation, and render possible the establishment of economically-operated super-stations. This will result not only in benefiting existing consumers, but also in the supply of districts hitherto unprovided for, thus rendering electricity available for purposes such as agriculture and cottage industries, for which otherwise it could not have entered into consideration.

As far as railway electrification in Europe is concerned, the future seems to lie in the extension of heavy main-line long-distance traffic, both passenger and goods, operated by means of electric locomotives.

As regards this country, there are still a considerable number of suburban electrifications to be carried out operated by multiple-unit stock; indeed, with about two exceptions, this is the only electrification in which we have so far taken any serious interest in this country.

There can be little doubt, however, that the future will bring about long-distance electrification also in this country, and this problem has to be looked at from quite a different angle and considered on a far broader basis than has hitherto been found necessary in considering local electrifications, such as those which for many years have been successfully running in this country. Far more attention will then have to be given to the experience and results obtained on the Continent of Europe, where heavy electrification is so extensively being adopted and is already working on such a large scale, than has been hitherto given or been necessary.

The operating conditions on a line like the single-track Rocky Mountains division of the Milwaukee, St. Paul, and Paget Sound Railway, with very few trains a day, where speed can be varied so as to improve load factor, are totally different from any condition under which electrification in this country is conceivable.

Experience such as can be gained from the operation of a line like the New York, New Haven, and Hartford, the New York Central, and the Pennsylvania Railway will be of considerable assistance, coupled with that gained on the Continent of Europe, in bringing about the development and the standardisation of the electric locomotive.

ELECTRICITY IN THE PROPULSION OF SHIPS.

By HENRY M. HOBART, B.Sc., M.Inst.C.E., M.I.E.E., M.Am.I.E.E.

In addition to the electric lighting of ships, which was promptly introduced in the early days of the electrical industry, other wide applications of electricity are now being made on board ship. The most interesting is that of using electrical machinery for propulsion. The writer has never made a serious study of the history of the subject. The earliest suggestion of which he has knowledge relating to the use of electrical apparatus for the propulsion of ships is that made by Heilmann in United States Patent No. 602,325 of 1898. The application was filed in 1895, when the Electrical Review was 23 years old. Heilmann proposed the use of a direct-current generator driven by a steam engine and delivering energy to propeller-driving direct-current electric motors. The following paragraph is quoted from the patent:—

"The engines are by this system not compelled to occupy a certain position in the vessel nor to have their crank shafts at a certain height, and they may be chosen of a perfectly balanced type completely exempt from vibrations. The propelling screws may be arranged in any suitable and effective manner."

The earliest electrically-propelled ship of any size of which the writer has any information was a 1,100-ton oil tanker used on the Volga River in 1903. This ship was fitted with Diesel engines, each of 120-h.p. capacity. Each engine was directly connected to a direct-current generator. The three propellers were each fitted with a direct-current motor, and the ship's speed was some seven to eight knots.

In 1908 two electrically-propelled fire-boats were placed in service by the city of Chicago. These fire-boats were propelled by twin screws independently driven by direct-current electric motors which derived energy from 200-kW direct-current generators mounted on the shafts of 1,700-r.p.m. steam turbines. The electrical equipments for these boats were designed by Mr. W. L. R. Emmet.

In September, 1913, the Diesel-electric canal-type tank barge *Tynemount*, of 3,400 tons displacement, made her first trial trip. She was designed and fitted under the supervision of Messrs. John Reid and Henry A. Mavor. The writer had the pleasure of being aboard during her first trial trip, and recalls her excellent performance. However, owing to subsequent disappointments with the Diesel engines, these and the electrical equipment were later replaced by reciprocating steam engines.

Also, in the September, 1913, the United States collier *Jupiter*, of 20,000 tons displacement, was put in commission. Her electrical propelling apparatus was designed by Mr. W. L. R. Emmet, and comprised a 2,000-r.p.m. bipolar 5,500-kVA. three-phase turbo-alternator, and two 36-pole propeller-driving induction motors of the wound rotor type for connection to large water-cooled resisters for starting, reversing, and manœuvring.

Up to the present most of the electrically-propelled ships, both naval and merchant, have been fitted with turbine-driven polyphase generators. The propellers have usually been driven by induction motors. These have in some instances been of the wound rotor type, with external resisters for starting, and in other instances have had special types of squirrel-cage rotors or other special arrangements suitable for providing the characteristics required during starting and reversing.

A more recent development is the employment of synchronous motors having features which provide induction-motor characteristics for starting and manœuvring. This has constituted an important advance. The low speed of efficient propellers (say, from 60 to 150 r.p.m., according to the type and speed of the

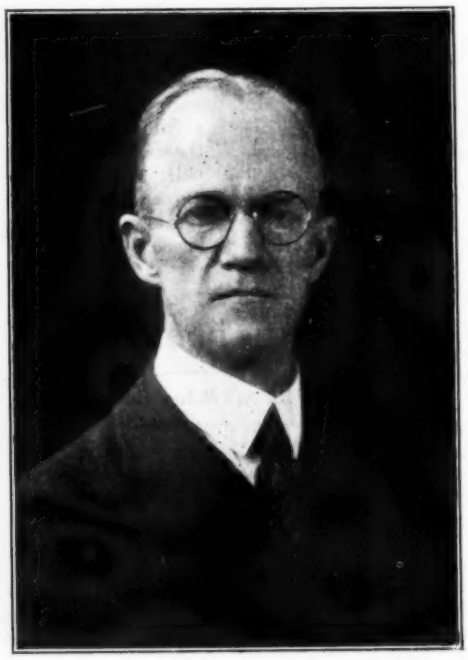
ship) has been considered to necessitate motors with many poles. If, for instance, the turbo-generator is bipolar and runs at 3,600 r.p.m., a 90-r.p.m. motor will have 80 poles. An induction motor with this large number of poles will be of large diameter and expensive for its output. Furthermore, its stalling torque and its power factor will both be low as compared with a motor with few poles. If its power factor is 0.75, both motor and generator must be designed for 33 per cent. more amperes (for a given voltage) than would be required with a unity-power-factor motor. The use of a synchronous motor operating at unity power factor decreases the size and cost of both generator and motor, and has been demonstrated in actual service at sea to provide the required operating characteristics. The synchronous motor has, over the induction motor, the further advantage of a much deeper air gap. It is also a more simple machine to repair and to renew parts.

There is a further advantage which the writer believes will be more generally recognised and utilised in due course. It consists in operating the synchronous motor with such high excitation that it will consume a leading current. This will permit of providing part of the generator excitation from its stator windings, and will decrease the burden placed on the rotor of the generator. The rotor is the limiting feature of the design both thermally and mechanically. With a rotor of smaller diameter, the speed in revolutions per minute may be higher, permitting of designing a more economical steam turbine.

It should be pointed out that since a ship is a self-contained unit, it is not necessary to employ a standard periodicity. If 70 cycles or 40 cycles should, for a given ship, be better than 60 or 50 cycles, there are not the objections to a special periodicity which would hold for land installations, where the importance of interconnecting systems is very great.

When Diesel engines are used for prime movers, it will, in the writer's opinion, be desirable to use a very low periodicity. If the Diesel engine's speed is 210 r.p.m., a four-pole generator will have a periodicity of only seven cycles per second. Induction motors for this low periodicity and for customary propeller speeds have very attractive characteristics. If the propeller speed is 70 r.p.m., the motor will have 12 poles. For medium powers (say 500 to 1,000 h.p.) such a motor will have convenient dimensions and be of low cost. Its power factor will be of the order of 0.95 at rated load, and will still be some 0.80 at quarter load. For a 60-cycle, 70-r.p.m. motor the power factor would be only some 0.8 at full load and 0.5 at quarter load. The full-load efficiency of the 7-cycle motor will be one or two per cent. higher than that of a 60-cycle motor for this speed and output, and will be about 5 per cent. higher at quarter to half load. The stalling load of the 7-cycle, 70-r.p.m. motor will be very high indeed, and consequently it can be rated up to its heating limit. With the application of modern insulating materials and processes, and modern knowledge of methods of forced cooling, it is obvious that such a motor will be light and compact, and of low cost. These considerations also apply to low-periodicity synchronous motors.

While this low-periodicity proposition is especially applicable to the Diesel-engine drive, the writer considers that it should also receive careful examination for the case of the steam-turbine drive—at any rate for medium powers. In this case mechanical speed reduction gearing would be interposed between the turbine and the generator. The turbine might, for example, run at 4,000 r.p.m. and drive a bipolar generator at 500 r.p.m. The periodicity would then be 8.3 cycles per second. For a propeller speed of 125 r.p.m., the motor would be built with eight poles, and would have the attractive features already described. This is a very different proposition from that which has already been employed on several electrically-propelled ships of interposing gearing between the propeller and a high-speed motor. In the latter case the low-speed wheel runs at the speed of the propeller (125 r.p.m.), as against 500 r.p.m. in the method which the writer is describing. The cost of a mechanical speed-reducing gearing depends upon the speed of its lowest speed member, and becomes more expensive the lower the speed of this member. Also in the latter case the direction of rotation of the gearing is reversed when reversing the ship, and its speed changes when changing the speed of the ship. In the former case the gearing always runs at constant speed in one direction.



Henry M. Hobart.

If gearing is required, it will be cheaper and will endure better if it is placed between the turbine and the generator instead of between the motor and the propeller. In other words, if part of the speed reduction is mechanical and part electrical, the mechanical reduction should come first, as in the plan described by the writer, and not last, as in the plan which has been employed. Nevertheless, the writer agrees that gearing is to be avoided if an equally economical solution can be found electrically.

Some 15 years ago, when the electric propulsion of ships was first at all widely studied, the geared drive was just being introduced. It has proved to be a formidable competitor, both for naval vessels and for merchant ships. As regards naval vessels, the geared turbine has been successfully applied on a large scale by the British Admiralty. Certainly no less successful has been the application of the electric drive to several classes of ships in the United States Navy. Similarly for merchant ships, although the geared turbine has up to the present been far more widely employed, there are already a good many instances of at least equally successful applications of the electric drive. Indeed, the advantage as regards manœuvring appears to rest with the electric drive. The geared drive is considerably handicapped by the need for providing for reversal of the turbine. That feature prejudicially affects the design and operation, but by no means to such an extent as to obtain for the electric drive any general admission of superiority. In the writer's opinion, the turbo-electric drive will, in the course of time, be conceded to have a distinct advantage as regards lower maintenance costs, and will be very attractive from the standpoint of prompt and effective control.

For merchant ships making very long voyages, the Diesel-engine drive would appear a logical development. Many such ships are in service. The greatly decreased fuel cost will, for such service, more than offset the high

initial cost of the machinery. At present, however, the Diesel engine for direct connection to the propeller has not reached the stage of development where it is considered thoroughly reliable. Consequently the best practice is to employ two engines and two propellers. The low-speed, direct-connected engines are very heavy and expensive for their output. By substituting the Diesel-electric drive, a merchant ship need have but one propeller. The electric motor or motors driving this propeller may integrate the power of two or more Diesel engines. Each of these may be of higher speed than for the direct-connected outfit. Diesel engines of small power (even for the same speed) have lower weight and cost per h.p. than large engines, and for 200 r.p.m. or more, the decrease in weight per h.p. is still greater. It is also more practicable when at sea to make repairs on these smaller engines. The withdrawal of one set from service for repair will less seriously affect the progress of the ship the greater the number of sets. Thus, if three sets are provided, the withdrawal of one from service will reduce the available power to two-thirds, but this will only reduce the speed of the ship by some 13 per cent., since the power required is roughly proportional to the cube of the speed.

The late Mr. Henry A. Mavor recognised at an early date the importance of the plan of integrating at a single shaft the power from more than one Diesel-engine-driven polyphase generator, and devised a so-called multiple motor of the squirrel-cage type provided with two or more independent stator windings for different and non-interfering pole numbers. These windings were supplied with electricity of different periodicities from independent generating sets which did not need to be synchronised. This was important, since the operation in synchronism of two generators driven by Diesel engines is not so satisfactory as the corresponding synchronous operation of two turbine-driven generators, the uniformity of angular speed being greater in the latter case.

But with 6-cycle sets of a given speed in revolutions per minute, the departure from uniform speed may be ten times greater for a given limiting electro-magnetic variation, than with a 60-cycle set, and this is a further advantage of the low-periodicity design which has been already described by the writer.

Some engineers have considered the disadvantage from the standpoint of parallel operation to be so great that they have concluded that Diesel-electric propulsion should only be employed with direct-current generators and motors, which was the plan employed in the 1903 Russian oil tanker to which reference has already been made. The writer's opinion, however, is that, according to circumstances, both polyphase current and direct current will be employed in Diesel-electric systems.

The next decade will see an interesting competition between—

(1) Geared turbine drive.
(2) Turbine electric drive.
(3) Direct Diesel drive.
(4) Diesel-electric drive.

The direct turbine drive is not included in the list. It was employed on a good many ships before the advent of the geared turbine drive, but it has been demonstrated to be inferior, especially as regards fuel costs, and is no longer employed in new constructions.

The fact, to which allusion has already been made, that each ship is an independent unit, should lead to fitting otherwise similar ships with different drives and comparing results in a given service. This has frequently been done in marine engineering. It will lead to valuable comparisons being made not only between geared turbine and direct Diesel drives on the one hand, and electric drives on the other, but between various alternative electric drives. Evolution toward better designs ought consequently to be more rapid than, for example, in the case of systems of railway electrification, where agreement on a standard system is very important from the standpoint of interchange of traffic.

Directing our attention to the available electrical systems of propelling ships, it would appear that the natural field for the Diesel-electric system would be for merchant ships making very long voyages. The superior economy in fuel would permit of refuelling at ports where oil is cheap. A 3,000-ton 9-knot cargo boat with Diesel-electric drive could proceed for 50 days on 200 tons of fuel oil. For ships making short voyages there does not exist this reason in favour of Diesel engines, and the turbo-electric drive would usually be more desirable.

It is customary to assume that for turbo-electric ships the propellers must be driven by polyphase motors. The writer considers that study should be given to the advantages, in certain cases, of fitting the propeller shafts with direct-current motors and interposing mercury-arc rectifiers between the polyphase generators and the motors. As a concrete case, the writer would suggest a ship equipped with three 9,000-kW 3,000-r.p.m. polyphase generators with star-connected stator windings, supplying eight 4,000-h.p. 1,500-V direct-current motors. The efficiency of the rectifiers will be 98 per cent., and they will add but little to the total weight and cost of the installation. The direct-current motors will be installed in pairs to drive the four propeller shafts at 75 r.p.m. For this speed, very sturdy and efficient 4,000-h.p. 1,500-V direct-current motors of convenient dimensions may be designed. The efficiency will be higher than that of induction motors for such a low speed, and the characteristics as regards starting, reversing, and speed control will be much more attractive. The direct-current voltage may be adjusted by control of the excitation of the polyphase generators.

Associated with the electric propulsion of ships is the electrical operation of auxiliary machinery on deck and in the engine-room. While such operation is increasing, it could be wished that the progress might be less slow. The source of excitation for the main drive should also supply the electric auxiliaries. The quickest progress is being made in the electric drive of auxiliaries in the case of Diesel-engine ships. Direct-current motors are almost always employed for driving auxiliary machinery, as their characteristics are very suitable for most cases. As an exception should be mentioned submersible motors, which are at present usually of the squirrel-cage type. Electrical operation of deck machinery should considerably decrease the time occupied in loading and unloading, and thus decrease the port charges which often constitute the largest item in the operating expenses.

Motors for driving auxiliary machinery on ships should be especially robust, and impervious to salt-laden air. The technique of the art of insulating and protecting motors is now so advanced that there ought to be no misapplications in this respect. This would appear to be a very suitable field for pipe-ventilated motors and for double-shelled designs with air circulated between the inner and outer shells by a fan carried by the motor. Such types should be more suitable than plain totally-enclosed motors.

In connection with the use of electricity on ships, both merchant and naval, attention should be called to the two following significant publications:—

"Regulations for the Electrical Equipment of Ships," published in 1919 by the Institution of Electrical Engineers; and

"Recommended Practise for Electrical Installations on Shipboard" (Marine Rules), published in 1920 by the American Institute of Electrical Engineers.

Electric Welding.—Electricity is now being more widely used every year in the construction of ships. Both resistance welding and arc welding are employed for joining steel plates of many parts of ships. On a few small ships, the hull plates have been joined by arc welding instead of being riveted.

A careful study of the possibilities of saving in cost and decreased weight, and consequently increased cargo capacity, has led the writer to believe that a considerable part of the work now being done by riveting will in the near future be done by electric welding.

NOTES FROM "REVIEWS" OF FIFTY YEARS AGO.

Extracts from Our Pages in 1872.

To Our Readers.—We need not dwell upon the importance of the applications of Electricity. It would be better to review the position that the chief branch—Telegraphy, a science itself—occupies in relation to the Public. The arrangement of the affairs of commerce is so intimately concerned with the progress of Telegraphy, that it is remarkable there exists no Journal considering both the scientific and the commercial aspects of the science. The requirement which *The Telegraphic Journal* is intended to fulfil is manifest. It has been admitted practically, and by Foreign Engineers, that England manufactures telegraphic lines and cables for the world; our cores are unrivalled; our wire is everywhere taken as a standard. Yet while applied sciences of far less extent have several representatives in periodical literature, the applications of electricity have no special organ. The telegraphist, the electrician, the electrotyper, or the electroplater has had to search for the records of his service through a chaos of irrelevant matter, and perhaps has been referred to articles written in a language with which he is unacquainted. In order in the future to collate the literature of the Science to one common centre, *The Telegraphic Journal* is added to the list of monthly magazines.—*November 15th*, 1872.

The "Theory" of Government Ownership.—The purchase of our telegraphic system by the State is in theory a matter of congratulation for the public, and we even look forward to the railways being bought in the same manner. We say in theory, because in England the principle obtains that what belongs to the Government belongs to the people. But, unfortunately, in the case of the telegraph, it is too much in theory and too little in fact that we derive benefit from the change which we expected would prove to be so advantageous.—*November 15th*, 1872.

Formation of the Eastern Telegraph Company.—At extraordinary general meetings of the British Indian Submarine, Falmouth, Gibraltar, and Malta, Anglo-Mediterranean, and Marseilles, Algiers and Malta Telegraph companies held on the 1st inst., resolutions were unanimously passed confirming and completing the amalgamation of the companies, under the title of the Eastern Telegraph Company.—*November 15th*, 1872.

The Leading Article Held Over.—Pressure on our space compels us to postpone our leading article on "International Telegraphy in Time of War." It will appear in our next issue, which will also contain valuable papers on "Telegraphic Batteries," and "Ampère's Theory of Magnetism."—*December 15th*, 1872.

Cable to Australia Opened.—A Banquet takes place to-night (the 15th inst.), at the Cannon Street Hotel, to celebrate the opening of telegraphic communication with Australia, and a wire is to be brought into the room for the purpose of communicating with Australia. A banquet is to be held at Melbourne the same evening. A third will take place at Adelaide, and it is hoped that others will be held at Sydney and Brisbane.—*November 15th*, 1872.

Aspects of International Telegraphy During War-Time.—Though Peace and War are obliged, for the sake of appearances, to sustain a sort of formal opposition to each other, they are, nevertheless, such excellent friends in reality that it is difficult to know how one could ever survive the other. War has afforded practice for doctors, has procured news for editors, has led to discoveries in nosology, has opened vast regions for commerce, and has furnished with facts and statistics airy speculators of all sorts. Peace, on the other hand, is always willing to see her inventions and discoveries adapted for purposes of destruction to human life. Her improved knowledge of shipbuilding, of mechanics generally, of chemistry, of optics, are all at the service of War. But is her old friend as welcome to the last adaptation of one of her most vital discoveries—the electric telegraph? Peace will have to draw the line somewhere, and it looks as if it might be here. For while the construction of systems of telegraphy would be of the greatest use for warlike purposes, their destruction would be equally an object in the same cause; and such a policy as that would be so diametrically opposed to the interests of peace as to make it imperative to consider the aspects of international telegraphy in time of war.—*January 15th*, 1873.

Societies' Meetings for the Month (November, 1872).—Telegraph Engineers.—November 27th, at 7.30 p.m.; Council meeting at 6.30 p.m.

Meteorological Society.—Ordinary meeting, November 20th, at 7 p.m.; Council meeting at 6 p.m.

Early Well-Wishers.—To Correspondents: Sir Charles Wheatstone; R. S. Culley; C. W. Siemens; Latimer Clark; R. Sabine; W. H. Preece; S. E. Phillips; C. V. Walker; F. C. Danvers; C. Brooke; J. Faulkner; Dr. Russell Reynolds; W. H. H. Clark (Philadelphia); H. G. Erichsen; E. Rosenbusch (Malta); Indo-European Telegraph Co.; Anglo-American Telegraph Co.; and J. Browning are thanked for their communications.—*November 15th*, 1872.

Seekers After Truth.—Under "Notices of Books" (*January 15th*, 1873) we reviewed a "Reprint of Papers on Electrostatics and Magnetism," by Sir William Thomson, D.C.L., LL.D., F.R.S., F.R.S.E., Fellow of St. Peter's College, Cambridge, and Professor of Natural Philosophy in the University of Glasgow. The review opened in the following terms:—"That men of science should rest upon well-earned laurels would not be a startling fact, even if it were true; and that the fact has no existence in truth is a matter clear to the most ordinary observer. There are few of our scientists that commenced work, say thirty years ago, who are not now in their laboratories, still cross-questioning nature as closely as when their first papers were presented to the world. Thirty years' work has brought fame which could not be extended, yet the old pursuits are followed as assiduously as ever. Evidently our great philosophers work not for fame, but indeed as lovers of truth."

The Edges Cut!—"The edges of the Journal are cut throughout; the Advertisements must, therefore, be seen."—*November 15th*, 1872.

When the "Review" was Forty.—In our 40th Birthday Issue (November 15th, 1912) an article entitled "Many Happy Returns" was contributed by Sir Wm. H. Preece, K.C.B., F.R.S. We make a few extracts:—

"The Electrical Review made its first public appearance on November 15th, 1872, exactly 40 years ago, as the 'Telegraphic Journal.' In the following January were added to that title the words 'and Electrical Review.' I took a keen interest in the paper, and for a short time edited it, but the transference of the telegraphs of the country from private companies to the State threw such a burden of work upon my energies that I had to clear away all other work. . . . The year 1872 saw the birth also of the Society of Telegraph Engineers, and the first number of the Review reports the seventh ordinary meeting of that Society under the first president, Sir William Siemens, when a paper was read by W. H. Preece, Esq., on 'Lightning and Lightning Conductors.' . . . The Electrical Review led to the introduction of the *Electrician*, in 1878, the *Electrical Times* (which was first known as *Lightning*), *Electricity*, and many others at home. . . . The life of the Electrical Review is a history of the life of the electrical industry. . . . There is one point connected with the Review that is very marked—its unwavering adherence to the policy with which it set out when inaugurated in 1872, and which it has maintained to the present day. . . . I must congratulate the Editors and Proprietors of the paper upon the position that they have so well maintained, and I trust that I may live long enough to compliment them at some future day on the jubilee of their achievement."

Unfortunately Sir William's hope was not realised, as he passed away less than a year later—on November 6th, 1913.

Braincraft v. Handicraft.—When the Electrical Review celebrated the completion of its 25th year, the great engineering strike was in progress, and a few weeks later (in our issue of December 31st, 1897), we printed a letter on the dispute from the Duke of Argyll. It was headed by us "Braincraft *v.* Handicraft," and as we then described it as the most sensible letter that we had seen on the disastrous strike, so do we also regard it as a communication of great interest and value to-day:—

"Dear Sir,—I lament with you this disastrous strike of engineers. You ask me if I have no suggestion to make as to preventing such suicidal contests. I have only one suggestion—more knowledge of the natural laws which determine 'value' in all things, 'labour' not excepted. As far as I can see, the demand made by the employers as to the exclusive control of the management of their enterprises is an absolutely just demand and necessary; and if the refusal of the employed does really turn on this, they are fighting against nature and against justice. Braincraft is the governing power in all industrial enterprises, and all attempts to make it subject to handicraft, which falsely monopolises the title of labour, must end in discomfiture and in disaster to all concerned. If this law cuts at the root of trades unionism, as the leaders allege, so much the worse for trades unionism, because it is a natural law, which any man can see who exercises his reason dispassionately. But trades unionism can do, and has done, much when properly directed, without entering on the unnatural crusade into which it has been seduced by misleading leaders.—Yours, &c., Argyll."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Liverpool Sub-Centre: Chairman's Address.— *Abstract.*

At the opening meeting, on November 6th, of the 1922-23 session of the Liverpool Sub-Centre of the North-Western Centre of the Institution, Mr. B. Welbourn, chairman, delivered his address, which was illustrated with kinematograph films and lantern slides. Mr. A. S. Barnard, chairman of the North-Western Centre, was present, and addressed the meeting on the value of the Institution to its members.

Mr. Welbourn, who recently paid a second visit to Canada and the U.S.A., and thus had an opportunity to note the progress that has been made there in all things electrical during the past 15 years, said, *inter alia*:—

Telephones.—The first thing that struck me was the extensive use of the telephone, both for short and long-distance work. Of the approximate 14,300,000 telephone stations in the U.S.A., about 850,000 are of the Strowger type, and about 40,000 are of other types. The annual growth of all stations is 6 per cent., but it is significant that the annual growth of automatic stations is approximately 10 per cent. In Los Angeles (700,000 people) there is one telephone to every four people, and telephones are being connected there at the rate of 200 per working day with no sign of saturation ahead. The whole system in Los Angeles is being converted to the Strowger automatic type as quickly as plant can be delivered from Chicago; two exchanges are being equipped in New York with automatic telephones.

Long-distance telephony has made considerable progress; it is possible to telephone by means of main underground paper-insulated lead-sheathed cables, to which Pupin loading coils and thermionic valve repeaters are attached, over 15,000 miles, although the present commercial limit is about 1,000 miles.

Broadcasting.—Owing to early lack of control of broadcasting stations, of which there are about 500, things seem to have got into a terrible muddle in the States, where considerable admiration was expressed for the leisurely, but orderly, way in which the matter is being tackled in this country.

It is estimated that there are about 2,000,000 reception sets in the States, of which one-half has been made by manufacturers and one-half by amateurs. The manufacture appears to have outgrown the demand, and the makers were said to be loaded with unsaleable stock. It is significant that a good deal of second-hand wireless apparatus is being offered for sale.

Electricity Supply.—During the month succeeding my departure from Liverpool I did not see a single gas flare used for illuminating purposes; I only came across it for suburban street lighting about 10 miles from Chicago, but am not conscious of having seen it again through the succeeding 25 days except in the streets of Pittsburgh, Pa., where there is ample natural gas.

In Chicago the Commonwealth Edison Co. has 626,450 kW of plant installed, of which 230,000 kW is in the Fisk Street station. The maximum demand in this city was well over 500,000 kW in December, 1921. With a population of 2,700,000 people, there are 536,982 consumers, of whom 425,200 are residence consumers, and the total kW-hours developed by the company in 1921 was 1,928,271,940, *i.e.*, 714 kW-hours per head of population. The number of new consumers added in 1921 alone was 62,287, and they require a car-load of meters per week to keep pace with the new service work. The total capital investment is $136,310,574.37, say £30,000,000. Comparing these figures with those for Greater London (population cf 8¼ millions), for the company and municipal undertakings (thus for the most part excluding all railway load) from the period 1919-20 to 1920-21 the total increase in the number of consumers was in round figures 25,000, bringing the total up to approximately 340,000. During the same period the increase in the plant installed was about 12,000 kW. There was an increase of nearly 40,000,000 in the kW-hours sold, bringing the total up to nearly 700,000,000. The total capital investment now stands at about £38,000,000, exclusive of the amount specially invested in power houses for transportation supplies. To the above figures we can add approximately 560,000,000 kW.-hours for the total energy used for transportation, bringing the approximate total for the last complete year to nearly 1,300,000,000 kWh—that is, about 155 per head of population. Comparing this with Chicago, it will be realised what an immense amount of leeway has to be made up in the capital city of our country alone before the use of electricity reaches the state of development attained by our American cousins.

How is it that this great business is done? One would expect that the cost of electricity to power and domestic users must be considerably lower than it is in this country. With the exception of the Ontario scheme, I do not think that this is the case, but it is difficult to make a direct comparison owing to the different money values obtaining in North America and in this country. The real explanation lies in the fact that electricity is a *habit* with most people in the States and Canada. The States and Canada are largely new countries wherein gas had not become entrenched when electric lighting first became available, and the growth of most of the cities has been coincident with the electrical era. In many places both the gas and electrical interests are under the control of one company, with men at the top who have had the right vision to relegate gas to its proper function of heating, and to reserve electricity for power and lighting. The advent of electric light into the home has been followed up by very active propaganda by salesmen of electrical accessories, while the companies have extensive showrooms, in which prospective consumers can see apparatus in actual use before they commit themselves to a purchase. I would not like to create the impression that the electricity supply authorities in this country are unprogressive, but the above figures show what an immensely greater business awaits them. Apart from railway electrification, which is only developing slowly, much greater attention should be paid to securing the immense domestic load, which may be as great as all the industrial business, and less subject to trade fluctuations. This load is not to be secured by merely cutting the price of electricity; it will require vigorous propaganda and salesmanship in the best sense of the word, the removal of all unnecessary restrictions, and arrangements to enable people to secure the apparatus without which they cannot use electricity. We are apt to forget that it is a feature of electrical appliances that their cost is frequently high compared with the value of the electricity they use in a year. To meet these points we must have: (*a*) a reasonable, but not necessarily a very cut, rate for electricity; (*b*) a system of hire or hire purchase of the more expensive pieces of apparatus; (*c*) in many cases hire-purchase wiring of houses; (*d*) a liberal practice with regard to laying mains, show rooms, demonstration of apparatus, and giving to the public what is generally known as "service."

In America most factories and the street, elevated, tube, and high-speed inter-urban railways are run electrically. Immense loads are provided by the local and express lift systems, which are used in every important office building, and there would seem to be much room for improvement in this direction in our own country. At night large blocks of power are used by the electrical sign advertisements, but despite the big power loads referred to, I was very much impressed everywhere with the steadiness of the pressure supplied for incandescent light. The quality of the street lighting is also for the most part quite good.

In one hydro-electric area the total cost, including all capital charges, depreciation, &c., per kWh. at the power-house busbars is 0.2 cent; 0.35 cent per kWh has to be added to cover all the transmission charges over a 250-mile line to the point of delivery, making a total of 0.55 cent, so that the cost of transmission is much more important than the cost of generation. In this connection the power available from some hydro-electric systems fluctuates more than one had imagined it to do. In the area in question in the last 25 years the rainfall has varied from 10.25 in. to 49.45 in. per annum, and most of it occurs in three months of the year only. It follows that steam stations have to be employed on some parts of the system and, in one case, 30 per cent. of the kWh sold last year were derived from the steam plant. The steam stations in California are usually supplied with oil fuel, which fluctuates considerably in price; were it not for this latter factor and the feared exhaustion of oil supplies, it is not unlikely that more use would be made of steam stations, especially as, at average prices of oil, the total cost of generation on the Pacific Coast is just about the same as the cost of hydro-electric power delivered over such long lines as the one referred to.

A great deal of interconnection of systems and stations has been carried out voluntarily. An outstanding example of the value of liberal linking up was illustrated in the spring of this year, when approximately 160,000 h.p. of generating plant broke down in one week in the various stations at Niagara, and yet the interruption of supply to consumers was negligible. One ounce of practice is worth pounds of theory.

In big cities, which have local steam stations and distribute by means of underground cables, the continuity of supply is excellent. In other cities, which are dependent for their supply on overhead transmission lines and overhead distribution networks, the supply is not by any means so good, particularly in those districts where the overhead lines are much affected by lightning and by snowstorms.

Cables.—So far as power cables are concerned, there is a good deal of experience in the States with 24,000 and 13,200-volt 3-core cables, and the records disclose that a good deal of it has not been happy. The trouble with underground cables appears to have been due both to defective manufacture and jointing and to overloading, partly under war conditions. A great deal of attention is being concentrated on the development of 3-core high-voltage cables, including those for a working pressure of 33,000 volts. The necessity for this arises out of the big loads to be transmitted and the attitude of the fire insurance companies to overhead wires,

especially as so many of the residences are built of wood, and because of the hindrance that wires are to the fire brigades before they can get to work. It would seem that the use of underground cables will rapidly spread in the residential areas.

Transmission Pressures.—A great deal of the success or otherwise of very high-pressure transmission lines depends on the suspension-type insulators. It is notorious that these were exceedingly unreliable down to five years or so ago, and it is very satisfactory to know that the makers in the States and Canada, as well as one well-known firm in this country, have developed products which can be used with every confidence. In this connection it is my belief that insulators built to the new B.E.S.A. specification No. 137/1922 can be depended on for satisfactory service, but, in my opinion, it is desirable to have a high-frequency test added when next the specification is revised. In order to get the best practical result from such a test it seems desirable that the wave train should be damped so as to simulate as closely as possible that produced by lightning.

Railway Electrification.—The question of a.c. *versus* d.c. railway electrification for main-line working is very controversial, but there is no sign in the States that either system is winning. It is, however, significant that the Chili Government, Paulista Railway of Mrazil, Melbourne suburban railways of Australia, and the South African Government, have commenced their electrification with either 3,000 or 1,500 volts, d.c., and that the French Government has adopted d.c. for main-line electrification. The Illinois Central Railroad has also adopted 1,500 volts, d.c., with catenary construction in and around Chicago. Whenever the question of inductive interference in telephone and telegraph circuits arises, the d.c. advocates are always able to point to the freedom from interference from their conductors. On the Milwaukee system the trolley wires are paraileled most of the way with the 100,000-volt 3-phase line which supplies energy to the motor-generator sub-stations; and, in practice, it has been found that this line causes no trouble to telephone and telegraph circuits, chiefly because it is provided with a continuous earth wire, and because the track overhead equipment is also provided over most of the route with a continuous earth wire.

RADIO DIRECTION-FINDING.

Effect of Local Conditions.

In the course of a paper on the effect of local conditions on radio direction-finding installations, Messrs. R. L. Smith-Rose and R. H. Barfield recently gave members of the Wireless Section of the Institution of Electrical Engineers an account of some of the experiments carried out during the past year by the Sub-Committee of the Radio Research Board on wireless direction finding.

The bulk of the work was done either at the Radio Research Station, Slough, or the National Physical Laboratory, Teddington.

The paper summarises the work of previous investigators on the same lines, and indicates why further research was necessary. It then describes experiments which provide quantitative data and definite figures which show the extent in certain cases of errors produced.

Modern direction-finding installations are well able to detect variations of less than 0.5 deg. in the direction of arrival of the waves under observation. There are, however, many causes which may prevent the readings so obtained from corresponding to the absolute direction of the transmitting station observed to this degree of accuracy.

By far the most important classes of errors experienced in practice are those which have been somewhat vaguely termed "night effect," implying the variation in the apparent direction of arrival at the direction-finding station, a phenomenon which is observed with nearly all transmitting stations between sunset and sunrise. These variations commonly amount to 20 deg. and have been observed by the authors to exceed 40 deg. on certain occasions. Little is known, however, as to the cause producing these effects, though much has been surmised. No practical system has been put forward which avoids these errors, and there is, at present, little more to be said about them save that, by reason of their existence, radio direction-finding is practically restricted to the daytime except over very short distances.

Second in importance is the class of error dealt with in this paper, namely, the errors which are produced by the immediate surroundings of the installation.

Effects of this kind may be caused by neighbouring objects, or by local geographical conditions, and while the errors produced will be constant under ordinary circumstances and thus permit of correction of the bearings, in other cases it may be necessary to avoid all possible errors at the site of the installation. It was known previously that such objects as cliffs, hills and mountains, trees, masses of metal work, and overhead lines would produce very serious errors on a direction finder operated in the vicinity, while the special case of the effect of the metal hull of a ship has seriously engaged the attention of wireless engineers ever since the first ship was fitted with directional apparatus.

Notwithstanding the previous work, however, there is insufficient data on the matter and it is very difficult to obtain for direction finding an absolutely ideal site, which is not prohibitive for other reasons, particularly in the vicinity of towns.

The experiments described in this paper were therefore carried out in order to obtain some quantitative knowledge of the disturbing effects of surrounding objects on a directional receiving set.

The general conclusions thus arrived at are that masses of metal work comparable in dimensions with the receiving coil do not perceptibly produce any errors in the bearings indicated by the latter except when placed within a very few feet of the coils. As a safe precaution it is as well to keep the space of, say, 10 ft. round the coil fairly clear of even small pieces of metal, as the cumulative effect of several small pieces may become quite appreciable. For this reason it is advisable to ensure that the hut or other structure containing the direction-finding set is as free as possible from metal in the way of joint-plates, door and window fastenings, &c., and that metal oil stoves or lamps are not placed too close to the receiving coils.

When, however, the extent of the metal work in the neighbourhood is moderately great, the resulting errors in observed bearings become very much more serious. As an illustration of the order of the errors which may arise in such cases, the results of an investigation carried out on a large metallic tubular construction are mentioned by the authors. The "tube" or tunnel was of approximately semi-circular cross-section, being formed of a number of curved, corrugated iron sheets bolted together and resting on flat, similar sheets placed on the ground.

The greatly increased effect of metal work when placed in the form of a partly or completely closed loop is well demonstrated by the results, and illustrates the effect which might be expected if, for example, a directional wireless receiver were installed in a corrugated-iron building. The continuity of the metal structure would appear to be very important, and even with such large masses, the nearest portions of these have by far the greatest effects. For example, with the coil receiver placed inside the tube near the centre, the removal of a section of the tube forming the top sides reduced the error in the apparent bearing of Paris from 14 deg. to 1 deg. Similarly, by unbolting two adjacent sections and slightly separating them, a change of 2 deg. or 3 deg. was produced.

With the receiving coil set up along the outsides of the tube, the errors observed were very much less, ranging from 5 deg. to 9 deg. at a distance of 2 ft., to about 2 deg. at 3 ft. from the side of the tube. Also, when the coil was placed on top of the tube the errors varied from 2 deg. to 6 deg.

As a further example of the effect of large masses of metal work, the effect of the metal hull of a ship may be instanced.

When the arriving waves come from either approximately fore and aft or athwartships, the error in the reading is reduced to zero. In intermediate directions the results are in error by amounts varying up to 22 deg. in either direction. There is a tendency for the readings to be concentrated along the fore-and-aft line of the ship. There is no appreciable difference in the error incurred on different wave-lengths (*viz.*, 2.6, 3.2 and 4 5 km.).

When the mass of metal work is very large compared with the receiving coils, as in the case of a ship, the resulting errors in the observed bearings on the direction finder may be very serious; although, when the set is fixed in position on the ship, the necessary correction may be made.

The effect of masses of metal work in producing large errors in the reading of a radio direction finder may in some instances be utilised for the location of such metal work, when the latter is not visible or when its presence is not readily detected by other means. An interesting example of this was recently obtained at the Aberdeen University direction-finding station of the Radio Research Board.

By means of a portable directional receiving set, the authors explored the site and found that the errors were closely associated with a line of manholes indicating the location of a sewer crossing the adjacent fields. It is to be expected that large masses of buried metal work, such as gas and water mains, will have a similar effect in their vicinity.

A possible cause of errors which is frequently encountered in selecting a site for a direction-finding set is the presence of overhead conducting wires. When the wires extend for a

considerable distance, the effects produced in their neighbourhood can be very large indeed.

With the frame coil set up immediately underneath telephone wires along a road, the readings obtained were considerably different from the correct values, and the bearings changed considerably from time to time during the tests. A possible cause of the rapid changes is the alteration of circuit conditions on the telephone wires at the various exchanges to which they are connected.

Errors ranging from 12 deg. to 70 deg. may be produced on a direction-finding coil mounted immediately underneath telephone wires some 20 ft. high. The errors diminish rapidly as the coil is moved away from the wires, but, even at the distance of 120 ft. from the line of wires, the errors may be a few degrees.

The explanation of the above effects must remain very obscure, since it is impossible to realise the conformation of the circuits of the telephone lines at any particular instant. In one sense the overhead wires may be pictured as constituting the top side of a huge vertical frame, of which the earth forms the lower side, and the vertical sides are formed by the connections to earth at the various exchanges. An electro-magnetic wave arriving at an angle to the plane of this large frame would suffer a partial absorption of that component of its magnetic field perpendicular to this plane, and the resultant field would therefore effect a direction-finder coil by giving an apparent direction deflected towards the normal to the plane of the wires.

Paris, on the 2.6 km. wave, showed some freak effects in the experiments and was evidently subject to some other influence, possibly a resonance condition in the overhead line circuits. It would appear that the errors produced are not directly influenced by the actual number of wires near the site, but depend on the conditions of a whole circuit of wires, which may extend over several miles.

The mere existence of neighbouring aerials, proved by their subsequent removal, made no appreciable difference in the observed bearings, and the effect of tuning the aerials was very small. An increased effect may, however, be caused by continuous, as distinct from damped, waves, and the effect also probably depends upon the relative directions of the aerial and the incoming waves.

Further experiments will be carried out on this effect.

The proximity of a closed coil may affect the readings of a direction finder in a manner similar to a tuned aerial system.

There is no apparent error due merely to the presence of a coil, when either on open circuit or short circuit. The bearings on the direction finder might, however, be appreciably affected by the presence of an open coil when working near the natural wave-length of the latter. The results are sufficient to justify the practice in accurate working of keeping all frame coils at least 100 ft. from a directional receiving set, especially if both sets of coils are in operation simultaneously.

The presence of trees has a considerable effect on the propagation of electromagnetic waves. The presence of clumps of trees between a radio-telegraphic transmitter and the receiver considerably decreases the signal strength at the latter, and growing trees can be used very effectively as aerials for the reception of signals over long or short distances.

A large tree may thus reasonably be regarded as being equivalent to a vertical aerial in which oscillatory currents are induced by the arriving electromagnetic waves, and these currents may give rise to secondary effects due to induction or re-radiation. Since, however, the tree will possess a fairly high resistance, and it is naturally an untuned circuit for most wave-lengths, the presence of a single, isolated, tree would not be expected to have very much effect on a direction-finder coil unless placed in very close proximity to the tree. With large masses or clumps of trees, however, a cumulative effect may be produced with regard to the secondary field, which may give rise to serious errors at a directional receiving installation.

The general trend is for the error in the apparent bearing to be progressive as the direction-finder set is taken into the junction of large masses of trees, and the error is a minimum at the point farthest from all the trees.

The most noticeable point is the extent to which the bearing may change for a very slight change in the position of the receiving set. These large changes are probably due to the difference in phase effects of the inductive fields from the different trees. The presence of trees within about 300 ft. from a direction-finding installation may produce quite large, measurable errors in the readings of the latter. As it is possible that the error may vary with the changing state of the trees at the different seasons, the error may be a variable one and hence is to be avoided if possible.

Large buildings, hills and mountains act as partial obstacles to the passage of electromagnetic waves, and the tendency is for the latter to be deviated around the obstacle. The effect of working inside a building was well demonstrated, where the errors in the readings obtained ranged up to more than 30 deg., whereas when the set was removed to its final position in an open field less than ¼ mile away, the maximum permanent error experienced was 2.8 deg. At the top of a stone tower about 60 ft. high, from which all the metal work had been previously removed, the maximum deviation error experienced was about 3 deg.

Owing to the great variability in the possible nature and disposition of the surroundings of a direction-finding installation, it is very difficult, if not impossible, to make general rules as to the effect of such surroundings. It is believed, however, that the results of the investigations given above are of value in augmenting the scanty evidence previously existing as to the distortion produced in the propagation of electromagnetic waves by various obstacles on the earth's surface. The experiments themselves suggest further lines of advance, and it is proposed to follow them as soon as opportunity permits.

SOUTH AFRICAN RAILWAYS.

ELECTRIC LOCOMOTIVES.

The decision of the South African Railways and Harbours Administration to electrify the section of its main-line track between Glencoe and Pietermaritzburg, a distance of about 171 miles, to which reference has already been made in our pages, has resulted in the contract for the supply of the locomotives being placed with the Metropolitan-Vickers Electrical Co., Ltd.

The locomotives, of which 78 have been ordered, have been designed to haul passenger and freight trains over the electrified area, and are to be so arranged that they can be worked alone or with other locomotives in multiple unit controlled by one driver. The conditions which have to be fulfilled are:—

1. Three locomotives coupled together shall be capable of hauling a train weighing 1,800 short tons up a 1 per cent. grade at a speed of from 21 to 22 miles per hour, and of hauling the same train on a level tangent track at 36 miles per hour.
2. The locomotives shall be capable of running at a speed of 45 miles per hour without injury to any part.
3. Three locomotives coupled together shall be capable of starting a train weighing 1,800 short tons on a rising gradient of 1 :100 and attaining a speed of 22 miles per hour in three minutes.
4. Three locomotives coupled together shall be capable of holding a train of 1,640 short tons on a falling gradient of 1 in 50 by regenerative action alone.

The normal duty which the Administration will call upon the locomotive to perform is for three locomotives coupled together to haul a train weighing 1,430 short tons from Ladysmith to Pietermaritzburg, a distance of about 129 miles, in a little more than seven hours, and in the reverse direction a train weighing not less than 625 tons in about 7½ hours. The locomotives are to be capable of performing a round trip from Ladysmith to Pietermaritzburg and back under these conditions once every 24 hours for six days a week. The gradients on the line between these points are mostly in favour of the loaded trains, the ruling gradient against the load being 1 in 65 compensated; the ruling gradient for the trains returning from Pietermaritzburg to Ladysmith will be 1 in 50 compensated. The loaded trains from Ladysmith to Pietermaritzburg will have to travel down this gradient, which for trains in this direction is equivalent to an average gradient of about 1 in 55; there are, however, a number of lengths of tangent track on a gradient of 1 in 50. During one period of the journey from Ladysmith to Pietermaritzburg the loaded train will have to be taken down a gradient about 15 miles long, which includes a number of short lengths of 1 in 50 tangent track.

The maximum gradient on the section to be electrified is as much as 1 in 30 uncompensated, but these gradients occur on an old line which will be used principally as an alternative route in the event of the main line being blocked; under these conditions, the loads will be reduced to the capacity of the locomotives on this steeper gradient.

The accompanying illustration (p. 752) closely resembles what the locomotives will look like when they are built. They are to be of the double-bogie articulated type, and to consist of two four-wheel bogies coupled together at their inner ends by means of a ball articulating joint, which will allow free movement between the trucks. The draw and buffing gear is to be mounted directly on the bogies, thus ensuring that no undue strains will be thrown on the locomotive body.

The four main driving motors are to be carried on the bogies, supported by suspension bearings on the axles and rose supports on the bogie framing, and will transmit their

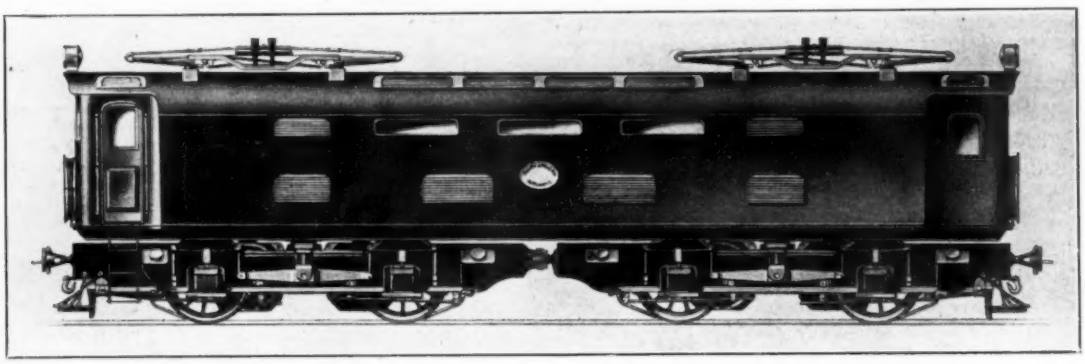
torque to the driving wheels by means of single reduction gearing. Each bogie is to be equipped with two motors; thus, the total weight of the locomotive will be available for adhesion. Each motor will be capable of developing 300 h.p. at the one-hour rating, which will correspond to a tractive effort of 5,800 lb. at 20.75 miles per hour; the tractive effort which the motor will be capable of exerting continuously is 4,100 lb. at a speed of 22.5 miles per hour.

Thus, the locomotive will be capable of exerting 1,200 h.p., which will correspond to a tractive effort of 23,200 lb. at the one-hour rating and 16,400 lb. continuously. The maximum tractive effort which the locomotives will be capable of exerting is about 43,000 lb. as determined by the adhesion between the wheels and the track. The motors themselves will be capable of slipping the wheels of the locomotive under any conditions of rail.

The body of the locomotive, which is to be of the box type, will be carried on two cross girders, that will form the bogie pivots, and support the longitudinal girders of the body underframe. Roomy driving cabs are to be situated at either end of the locomotive, and each driving point will be fitted with a controller, driver's valves, and the usual gauges, whistles, and sanding switches, so that the locomotive can be operated equally well in either direction. A gangway will be provided on one side of the locomotive, which will allow of easy access between driving compartments, and arrangements have been made for the simultaneous operation of coupled locomotives by a single crew from the leading driving point.

The control system will be electro-pneumatic; all the control apparatus, together with the auxiliary machines and the main resistances, will be mounted in the central compartment, which will be locked in such a manner that the driver will be unable to enter until all apparatus has been made "dead," thus ensuring that there will be no danger of the driver coming in contact with any high-pressure apparatus which is "alive."

The locomotives have been designed to collect electricity from an overhead trolley line supplying direct current at 3,000 volts by means of two pantograph collectors. A dual system of brakes is provided for, an air-pressure brake for use on the locomotive and a vacuum brake on the train. The locomotives are to be arranged for regenerative control, and the brake system is to be so arranged that, whilst the locomotive is regenerating, the brakes on the train can be applied without applying the locomotive brakes; should, however, the brake application exceed a certain predetermined limit, then the regenerative action will be interrupted and the locomotive brakes automatically applied.



Metropolitan-Vickers Electric Locomotive for South Africa.

Other particulars and the leading dimensions of the locomotives are as follows:—

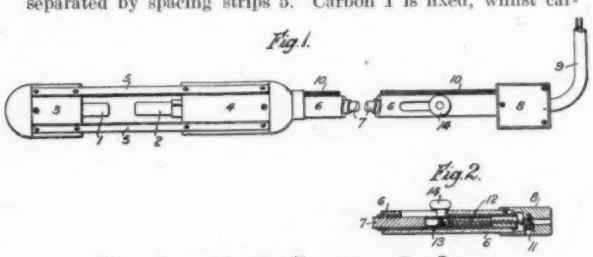
Weight in working order ...	about 65 long tons.
Weight of mechanical portion	about 37½ long tons.
Weight of electrical portion...	about 27½ long tons.
Type of locomotive	0—4+4—0.
Gauge	3 ft. 6 in.
Length of body	40 ft. 8 in.
Overall height of locomotive...	13 ft.
Overall width of locomotive ...	9 ft. 0½ in.
Diameter of driving wheel	4 ft.
Wheel base of bogie	9 ft. 3 in.
Weight per driving axle ...	16¼ tons.
Maximum safe locomotive speed	45 m.p.h.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.

An Electrical Oil Igniter.

Some weeks ago reference was made to the electrical installation of the *Volendam*, a large Holland-America liner built at the Govan shipyard, it being mentioned that in the boiler-room electrical oil igniters are used for lighting the furnace burners. By the courtesy of Messrs. Harland & Wolff, Ltd., Belfast, we are now able to reproduce a drawing of one of these igniters. Referring to figs. 1 and 2, the carbons 1 and 2 are mounted coaxially in housings of insulating material separated by spacing strips 5. Carbon 1 is fixed, whilst carbon 2 is connected to a rod of conducting material, which passes through an insulating tube 6 and is provided with a knob or handle, by means of which the carbon 2 may be moved against the action of a spring into contact with carbon 1 to strike the arc. Current is supplied by a flexible twin cable 9 to a connection box 8; one cable leads to a supply wire 10 connected to carbon 1, whilst the other cable is led to a terminal 11, to which one end of a spring 12 is attached, the other end of the spring 12 being attached to a conducting screw 13, which serves also to secure to the rod 7 an insulating handle 14, by means of which the rod 7 and carbon 2 can be moved against the action of the spring 12, so as to bring carbon 2 into contact with carbon 1 to strike the arc. The tube 6 and the rod 7 are made of such a length as to obviate the danger of the operator being burned when an oil burner is ignited. The method of operation is as follows: The head of the igniter is passed through one of the inspection openings in the boiler front and the opening where the carbons appear is put just in front of the oil burner. After the oil has been turned on, the arc is struck by the operator pushing the carbons together by the pressure of his thumb on knob 14 to bring the carbons into contact. Then the pressure of the thumb is slightly released, so as to form the arc, and as soon as the oil is lit the pressure is released altogether, after which the igniter can be withdrawn. In this way all risk of fire and naked lights is obviated.



Figs. 1 and 2.—An Electrical Oil Igniter.

Electrodes for Welding Non-Ferrous Metals.

To its series of 17 types of electrode for the welding of ferrous metals, Alloy Welding Processes, Ltd., 14/16, Cockspur Street, London, S.W.1, has added three new forms for use with copper, brass, and bronze. These are made on similar lines to the ferrous electrodes, but have a core of pure copper. The copper core is covered with a flux which adheres firmly to it and does not break away when subjected to workshop usage. The flux is of a special nature to suit the copper alloy to be welded, and produces a powerful

reducing atmosphere around the work to ensure good metal being deposited in the weld. As the temperature range between the welding and fusion points of copper and its alloys is very short, experience is necessary to prevent the metal becoming fluid or remaining in a sluggish condition. The firm recommends the pre-heating of the work and the use of a refractory material as support.

This development should prove of great value to users of non-ferrous metals in many industries.

The " Unit " Time Switch.

In the note on this device in our issue of October 20th we stated that " this, we believe, is new in that it constists of an adaptation of an ordinary alarm clock." In making this statement, we regret that we overlooked the prior claim of Messrs. Venner Time Switches, Ltd., who have had a similar invention on the market for a considerable time.

The " Excelsior " Electric Toaster.

The *Electrical News* recently published a description of the " Excelsior " electric toaster made by an American firm—The Perfection Electric Products Corporation, New Washington, Ohio. This device, as will be seen from the illustration (fig. 3), is equipped with two racks which can be reversed by the movement of a handle mounted at the top.

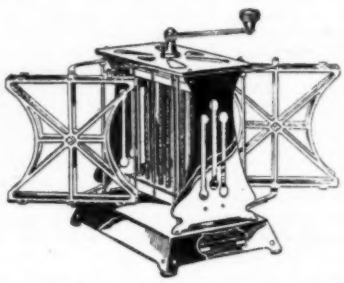


Fig. 3.—The " Excelsior " Electric Toaster.

The Geipel Float-type Steam Trap.

This trap has been designed not to compete with the Geipel expansion type, which has its own special function, but to meet requirements where float traps are more suitable or are preferred by users. It has been designed with a view to obviating the loss of steam which is occasioned by the usual construction. This loss is chiefly due to two causes, leakage at the valve and excessive radiating surface. A further object has been to overcome the difficulty caused by levers and pivots, through their being used to act in two directions; in the Geipel trap, they act in one direction only, so that wear and tear can be easily rectified.

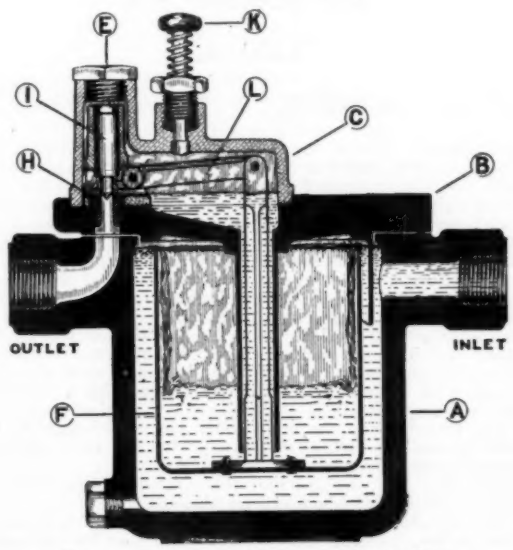


Fig. 4.—The Geipel Float-type Steam Trap.

The valve arrangement is such that the wear and tear is reduced to a minimum, whilst the material of which it is constructed, nickel, gives the maximum durability. Special facility has been provided for access to the valve, so that it may be periodically inspected and kept in good condition with ease. The valve (I) is situated above the cover (B) of the float chamber, so that it can be got at by simply unscrewing the valve head (E) without interfering with the steam connections and cover. The working parts can be exposed by simply removing the valve casing (C). With a view to minimising the loss by radiation, the float is made cylindrical and to extend the full length of the chamber, so that maximum flotation power is obtained for a given size of chamber. Further, this power is so multiplied by the lever arrangement that it controls valves of a larger size than those usually found in float type traps. For a given discharge capacity then, the size of the trap is reduced to the lowest limits, thus reducing the radiating surface.

The operation of the trap is as follows:—When steam is turned on, the float (F) is at its bottom position and the valve (I) is open and remains so until all condensed water is discharged, whereupon the float rises and the valve is closed by gravity and held tight by steam pressure. When water accumulates, the float again sinks and re-opens the valve (I). To examine the valve it is only necessary to unscrew the valve head (E). The valve (I) and the valve seat (H) are made of nickel and are easily renewable. An air valve is arranged in the body to ensure that there is no air lock in the trap when first starting up. To blow through the trap, the knob (K) is depressed either by foot or by hand. These traps will raise water two feet for every pound pressure. They are made by Messrs. Wm. Geipel & Co., St. Thomas Street, London, S.E.1.

The Webster Magnet Light.

Dark nights are coming and every motorist knows the annoyance of repairs or tire-changing on the road after dark; and even in his garage the difficulty of lighting some awkward part of his car when making adjustments. The many engineers who have wanted at times a handy, safe light for use in out-of-the-way corners, will be interested to know that such a lamp is procurable from the Webster Electric Co., 118, Victoria Street, London, S.W.1. The Webster magnet lamp requires no hook and yet directs the light "right there"; it is a new inspection lamp having an electro-magnetic base that will cling to any iron or steel part of a car or machine (painted or plain), whilst the lamp is alight. A flexible cord enables it to be placed just where required, and a nickel-plated reflector directs the rays on the object under examination, whilst it shades the eyes and protects the bulb against breakage.

The " Maco " Adjustable Template Corrector.

In our note on this device, in our issue of September 1st (p. 301) we gave the credit of the invention to Mr. E. James Brown, who is selling it. Mr. Brown disclaims the credit, stating that the template was devised by Mr. Albert Maden, of Newchurch-in-Rossendale.

REVIEWS.

Automotive Repair—Instruction Manual of Repair Jobs—Vol. II, for electrical service men. By J. C. Wright. Pp. xii+417; figs. 164. London: Chapman & Hall, Ltd. Price 15s. net.

" Typically American " is the comment which naturally occurs to the mind after reading " Automotive Repair: Vol. II, Electrical Service Work." Books of this kind appear to be popular on the other side judging by the number that have been produced in recent years; most of these volumes seem to be written by professors or, as in this case, by a " Director Federal Board of Vocational Education." These professors, it seems, go round to " service stations," where they analyse the repair jobs which have been done in a certain time, subsequently numbering, docketing, and tabulating them in true American fashion, for the typical American loves statistics before everything.

The present volume is a good example of its class. It is divided into two watertight compartments, the first of which deals with practical instruction on electrical repairs, fifty-six " jobs " having been chosen as those most often required by the electrical service man. Selecting a few of these jobs at random we have subjects such as: Cleaning spark plugs; installing a spot light; insulating starting cable; removing end-play in armature shaft; adjusting generator charge; undercutting mica; re-wiring lighting system; overhauling a magneto, &c. Each job is treated under three headings:—

(1) Operations necessary to perform the job. (2) Names of parts to be reviewed before performing the job. (3) Descriptions of operations.

Sometimes these instructions seem rather superfluous, for instance, Job No. 8, installing new light bulbs:—

(1) Remove lamp cover.
(2) Remove bulb.
(3) Inspect bulb.
(4) Replace with new bulb if necessary.
(5) Test lamp for operation.
(6) Replace lamp cover.

Repairing by numbers this might be called; one can almost hear the serjeant-instructor wheeling the electrical service man up into line, forming him into fours and performing

each operation according to plan. What happens if the job does not go exactly according to plan we are not told.

After each "job" the same ground is covered again in the form of questions—another favourite American custom.

Whether much useful instruction on practical repairs can be gained from reading such descriptions is a matter of opinion. Possibly after learning the theory from books and lectures it is better to rely on actual work in a garage or workshop.

The second part of the book deals with the theory of the subject and here the author seems to be more in his element; the eight chapters are as follows:

Magnets and Magnetism; Electromagnets; Electrical Units of Measurement; Electrical Measurements; Batteries; Generators; Starting Motors; Ignition.

This part of the book is quite good, the information being clearly set out and sufficient for all the needs of the electrical repair man in general. The theory in the first chapters is given in the conventional manner starting with magnetic lines of force and following the well-worn track through the hydraulic analogy. The chapter on "Generators" is especially good; a full description of the third-brush system of output control (for which the North-East Electric Co. appears to be responsible) is a useful feature.

The chapter on "Ignition" deals chiefly with battery-coil systems as would be expected, the magneto being treated in a rather summary manner. Nothing is said about British magnetos, but descriptions of the few American machines are included. The book is well printed and is fully illustrated throughout, many of the figures, however, being from catalogue blocks. A large proportion of the wiring diagrams are provided by the Delco and Remy Companies and these, as always, are models of what such diagrams should be. They have an excellent plan of showing two diagrams of each system, one entirely pictorial and the other entirely technical, the first appeals to the ordinary user and the second is welcomed by the electrician. Both diagrams are first rate in their way and other manufacturing companies would do well to follow this example. F. H. H.

Electrical Circuits and Connections. By W. R. Bowker. Pp. xii+211; figs. 166. London: Crosby Lockwood and Son. Price 15s. net.

The scope of this work is indicated by the sub-title which states that it is a technical, practical and operative treatise on direct, alternating, polyphase, and hydro-electrical engineering circuits.

In his preface, the author states that his book is practical rather than theoretical and mathematical. There is no doubt but that theory and mathematics are absent.

The work comprises the following sections:—

Introductory Terms and Explanations.
Continuous Current Dynamos.
Direct Current Motors.
Two- and Four-pole Shunt Motor and Auto-Starter.
Electric Traction.
Combined Lighting and Power Schemes.
Alternating and Polyphase Currents.
Fault Test Panel.
Rotary Converters, Hydro-Electric Lay-out, and Automatic Control and Operation.

These headings give some idea of the order—or rather lack of it—in the book, and a detailed examination does not make matters much clearer.

A great mass of elementary practical information is given without any basic principles which would enable a reader to grasp the true significance of this information. The book is very similar in many respects to the old-fashioned army drill books, but is far behind even them in accuracy and definiteness. Most of the information is common-place working instructions for operating electrical machines of different kinds, and it is to be hoped that no one will have an opportunity of trying to operate machinery solely on the ground of instruction received from this book. This is especially the case in connection with the starting of rotary converters and paralleling of alternators.

The one original point dealt with comes under the title of "Corona Solution." The author's explanation of corona is worth quoting in full.

"'Corona' phenomena is the result of a complex evolution of cumulative physical effects of electrical energy applied to a dielectric medium—the outcome of electrostatic condenser and electromagnetic stresses and strains and lateral, transverse dielectric surgings that eventually break down the insulating properties of the air dielectric."

This will doubtless be extremely illuminating to the artisan readers for whom the book was specially planned. Mr. Bowker, however, has evidently no dubiety in his own mind about "Corona," and states that with an arrangement produced by him a 220,000-volt, 3-phase transmission line could run with 2 in. spacing and ½ in. dia. wires. He also predicts that 3-phase transmission at 3/400,000 volts will soon be a comparatively inexpensive business.

The reviewer can only confess that he is wholly unable to understand either Mr. Bowker's definition or his solution.

The figures never get beyond mediocrity and in some cases are extremely poor. One misprint only was noted, *viz.*, C_2 for C^2 on page 5.

The fact that the book has gone through three editions proves that numerous readers have been found for it. These are deserving of the deepest sympathy.

Technical Electricity. By H. T. Davidge and R. W. Hutchinson. Fourth edition. Pp. 514; figs. 403. London, 1922: University Tutorial Press. Price 10s. 6d.

The first edition of this book was published in 1906, and it has now an assured place among the text books that one can recommend with confidence to the average engineering student. The larger page, improved diagrams and the general expansion of the text in this new edition should add to its popularity in spite of the fact that these improvements have necessitated the raising of the price to half a guinea.

In its earlier form as one of the "Organised Science Series" of text books the authors appeared to be hampered in their good intentions by the size of the page; many of the illustrations seemed to lack elbow-room and the descent into a peculiarly uninspiring small type in the case of some of the less important paragraphs was a weariness to the flesh. The present format is much more worthy of the book and consequently the use of the volume either for study or reference is more pleasant and satisfying.

The book is intended for first and second year students in electrical engineering at the technical schools and colleges and at the universities; for candidates for the various professional examinations for students of physics; and for shift engineers and test-room staffs. Messrs. Davidge and Hutchinson have maintained the original purpose of their work, namely, the bridging of the gulf between "Magnetism and Electricity," and "Electrical Engineering"; they have brought their book well up-to-date by suitable modifications and additions, and have entirely rewritten many of the sections in order to bring them into conformity with modern electrical engineering practice. Much entirely new matter has been incorporated, especially in those branches of the subject such as electric lighting, central station equipment, telegraphy and telephony, wireless, X-rays, &c., in which great progress has been made in recent years.

Particularly notable are the improvements in the sections on alternating currents, magnetic measurements, and motors and motor generators. One or two idiosyncrasies have come over from the earlier editions, including the working out of cross-sections of indoor wiring to six places of decimals of a square inch (page 452); also the sentence in which the Coolidge X-ray tube is described on page 477 is inaccurate—the incandescent cathode *provides* the stream of electrons, it does not increase the supply of them. But altogether the book is a good one, and the authors are to be congratulated on the renewed vigour and improved looks of their sixteen-year-old offspring.

LEGAL.

Soc. Anon. Internationale De Telegraphie Sans Fil, *v.* Ambatralos.

Mr. Justice Roche, in the King's Bench Division, on November 8th, heard a claim by the plaintiff company for £871 11s. 4d., in respect of wireless apparatus supplied to a Greek ship, alleged to belong to the defendant. The defendant, however, while admitting the contract, said that it was signed by him as agent for his brother, who owned the steamer, and that he was not, therefore, liable.

Mr. Samuels, appearing for plaintiffs, said that the defendant had acted as agent for his brother for some years and had offices in London, and the brother was the owner of two steamers which had been fitted with wireless by the plaintiffs. The contract having been admitted the issue of agreement was raised and that depended upon the construction of the contract. A contract signed by a person in his own name, without qualification, was, *primâ facie*, evidence that he was the contracting party, although in the body of the contract he might say that he was acting as agent for another person.

It having been decided that the contract having been admitted the onus of proof was on the defence.

The defendant was called, and in the course of his examination by Mr. Valletta, his counsel, said that he had never had any interest in the vessel in question. He had received accounts from the plaintiff company although it had obtained judgment against his brother in respect of the same steamer. Witness added that he had always informed plaintiffs that he was only an agent.

His Lordship said that in the contract it did not appear that defendant was the owner of either of the two vessels in question. The law was that if a man signed as an agent, and there was nothing in the contract to show that he was an agent, then he would be liable as a principal or a contracting party.

In cross-examination, the witness said that he informed the plaintiffs before signing the contract that he would have to communicate with the owners.

His Lordship said that the contract being with the owners of the ship the action should have been against the owner.

Mr. Samuels said that the defendant having signed the contract in his own name the plaintiffs were entitled to regard him as the shipowner, even though he might have inserted in the contract the words "acting for the shipowners."

His Lordship, in giving judgment, said that the question was whether the defendant was liable although he was only an agent and not the owner of the ship, and the plaintiffs contended that he was liable because he had signed the contract. The first issue was whether the defendant was the owner or part-owner because, if he were, it would be open to the plaintiffs to recover from him as principal. Having heard the defendant's evidence, he found that defendant had no material interest in the ship and that he was merely acting as London agent for the owner. He had signed the contract without qualification, but in the document he had described himself as "acting for the ship-owners," and the clause upon which the plaintiffs relied provided that the shipowner should pay so much as an annual rent. He considered that the defendant was not liable; there would therefore be judgment for the defendant, with costs.

Southern Brazil Electric Co., Ltd.

In the Chancery Division, on November 7th, Mr. Justice P. O. Lawrence heard a petition by the Southern Brazil Electric Co. for the sanction of the Court to a proposed reduction of capital.

Mr. Clauson, K.C., said that the company held shares in a large number of electrical companies in Brazil. It had a capital of £750,000, and it was proposed to reduce this to £425,000 by writing 10 per cent. off each of the 650,000 issued shares of £1 each.

His Lordship said the petition did not state whether this was capital lost or was represented by available assets.

Mr. Clauson replied that the whole trouble arose over the fall in the rate of exchange, and nobody could tell when it might improve.

His Lordship sanctioned the proposed reduction.

Halls *v.* Pert.

At the Shoreditch County Court on November 7th, Mr. Arthur Halls, of 21, Elsenham Road, Manor Park, an engineer, claimed "not more than £500" from Mr. Charles Pert, of 73, Bulwer Road, Leytonstone, an electrical engineer. He asked for a declaration that he and the defendant were partners in the business of engineers at 19, Mansfield Street, Kingsland Road. He further asked (1) for accounts and inquiries; (2) payment of what was due to him; and (3) such further or other relief as might seem just to the Court. Mr. Dickens, appeared as counsel for the plaintiff, and Mr. Pert in person. The plaintiff said that on May 8th he and defendant had a discussion as to a partnership, and after a time it was decided that it should date back from May 1st, although nothing was actually signed to that effect; agreements were being drawn up however. Finally, it fell through because the plaintiff would not agree to the book debts of £240 being included in the assets, as the defendant was only to pay £174 for a half share of the goodwill of the business, and the profits. All the defendant had paid was £20 on account. Plaintiff said cards were printed, defendant was introduced as a partner to customers, whilst a joint account was opened at the bank, upon which defendant signed several cheques. Defendant drew £20 while he was with the firm, saw customers, and gave orders to the staff. The partnership lasted from May 1st to July 3rd, during which time there was a loss, owing to various actions of the defendant.

In his defence, Mr. Pert said he had never been a partner, but was only on the premises to see if it was a business he could enter. He denied being introduced as a partner. He was of opinion that the book debts were not of the value given, so he decided to have nothing further to do with it. It was true he signed cheques, and the joint account at the bank, but he denied drawing anything out of the business. Mr. Dickens submitted that it was not necessary to have the papers signed to make him a partner; if he acted as one it was sufficient.

Judge Cluer said he must find that the defendant did not act as a partner, but he had gone in to see if he would become one. He had signed the joint acount at the bank, and that certainly did render him liable for any overdraft until he revoked it.

Mr. Dickens asked for leave to appeal, which was granted.

Payment for Electric Irons.

In the Shoreditch County Court on November 2nd, before Judge Cluer, Adolph Frigimblum, an electrical dealer, sued D. Rose & Co., of Whitechapel, hardware dealers, to recover a balance of £29 8s. for electric irons supplied. In the defendant's absence, and after a postponement, the amount was allowed by the judge. Defendant arrived 31 minutes after the decision and asked for a new trial, but as he was unable to pay at once the costs of the first trial the judge said that the decision must stand.

CORRESPONDENCE.

Letters received by us **after 5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Catalogues Wanted at Bermuda.

There is a dearth of up-to-date British electrical catalogues at this dockyard, and I should be glad of the help of your "Correspondence Columns" in making this known.

Catalogues of all types of electrical plant and apparatus manufactured by British firms will be gratefully received.

F. C. Hunt,
Electrical Engineer.

H.M. Dockyard, Bermuda,
October 26th, 1922.

Prospects in South Africa, British South-West Africa, or British East Africa.

Could any reader lately returned from, or conversant with, the States named above, supply me through the medium of this Journal, with information as to the prospects of securing electrical employment in those States?

Assoc.Amer.I.E.E.

November 10th, 1922.

Fixing the Price Per Point.

The problem set by Mr. J. Lander in your issue of November 3rd is one which caused a good deal of trouble in this command, where there is a very large number of huts and cottages supplied with electric power from War Department power stations, and no meters are installed.

The present system of charging is to divide the year into a summer period and a winter period and to calculate the number of "lighting hours" up to 11 p.m. in each period. Half the number of lamps installed are assumed to be "on" during the whole of the lighting hours, and the B.O.T. units estimated to be consumed per month are charged for at the same rate as metered supplies. Whether this is fair to consumer and supply company is open to argument. I am afraid it does not satisfy the consumer. He compares his charges with his "metered" neighbour's and finds them considerably higher, but the supply company has to remember that it is only human nature that the man who pays by meter will be very much more careful to use his switches than will the man who knows that his bill will be the same whether he switches off or not. Electric light in unmetered houses must, in my opinion, be much more expensive and, therefore, less popular than where supplies are metered, and I should say the system is almost impracticable in civil life. I shall be glad to see the letters of others who have tried it.

O. H. Campbell, Lt.-Col.

Southern Command,
Headquarters, Salisbury,
November 8th, 1922.

Electrical Trading Relations.

At the first E.D.A. Conference, and after asking the chairman's permission, I made bold to suggest that intertrade relations, trade discounts, &c., were matters having a vital bearing on the selling of electrical products. At subsequent conferences these subjects have been ruled out, and rightly so, in view of the confusion which their discussion may occasion. None the less, the opinion has since been expressed to me that such matters must be regularised if the electrical business is to have any settled future. At present selling in the electrical trade is little better than a wild scramble between manufacturer, superfactor, wholesaler and retailer, to get at the buyer. The prospect of a steady growth of trade—a growth which will bring to each party its proper share of the business—should make us cry a halt upon our present sales methods. They display complete ignorance of that simple plan that the way from the manufacturer to the buyer is through the wholesaler and the retailer, and that way alone.

A means must be found to operate the electrical trade according to this plan, otherwise the E.D.A. Salesmanship Conferences will fail or fall far short of their object, namely, to improve the efficiency of selling. These conferences can be a great co-ordinating force. They are already bringing together men whose sole work is selling electrical products, and I hope it will be possible to include in this year's programme an extra evening when subjects now obviously taboo can be discussed. Such a meeting would, I am confident, be well attended and would have the effect of clearing much lumbered ground.

In the face of a great electrical trade revival this wrangling between manufacturer, central-station engineer, wholesaler and retailer, must cease. It has served the purpose of a bad past, but has no place in an undoubtedly brilliant future. I would appeal to every trading section to rid the electrical industry of an incubus which it has borne too long.

W. E. Warrilow,
Lionel Robinson & Co.

London, *November 10th*, 1922.

BUSINESS NOTES.

Private Arrangements.—Fuller's United Electric Works, Ltd., Woodland Works, Chadwell Heath, London, E.—In pursuance of an Order of the Court a meeting of the trade creditors interested herein was held on November 9th at Winchester House, Old Broad Street, E.C. The chair was occupied by Mr. H. W. Humphries, one of the principal creditors. The meeting was called for the purpose of considering a scheme for the settlement of the company's liabilities. Under the scheme the unsecured creditors for amounts of £10 and upwards were offered income debenture stock carrying interest at the rate of 7 per cent., the stock to mature in 1932.

Sir Arthur Whinney said that from the proxies received the creditors were overwhelmingly in favour of the scheme. He thought he could say that 99 per cent. of the creditors were in favour of the scheme. It had to be remembered that the company was not in a position to pay cash for the goods it had received, and it was offering the creditors security for their claims. The amount due to the creditors was about £60,000, and there were note holders whose claims aggregated £250,000. He was afraid that if the creditors were to press for their right to receive cash the chance of their obtaining anything would be extremely small. The assets were not of a kind that would realise well under the hammer. As a going concern the thing was quite good. Break it up and the thing was quite bad. The company was asking the creditors to be patient and they would all be paid in full. The company required a moratorium. The income debenture stock offered to the creditors would be protected by a trust deed and a trustee. That was the most the company could do. It was necessary to put the company into a proper position of stability. In the past it had not been successful, and it was now proposed to cure some of the defects. It was recognised that the ills of the company could not be cured by the ordinary methods available to an accountant. They were ills which ought to be dealt with by a technical engineer. Mr. C. H. Wade had been consulted. He was the most eminent man the company could find, and on the whole he had reported satisfactorily on the business. Mr. Wade, however, called attention to certain defects which he considered ought to be remedied before the company could be placed in a sound position. In short, he said there was a necessity for re-arrangement in the lay-out of the factory. With a bad lay-out the various operations were wasteful, there was a restriction in output, and the quality of the goods was not uniform. Mr. Wade also pointed out that there must be an improvement in the manufacturing side of the business, and small additions to the plant, which would then be capable of producing three times as much as the present output. With a turnover of £450,000, which he said it was not impossible to secure, there should be a very substantial profit. Mr. Wade suggested that it was by no means impossible for the company to earn a profit of £100,000 a year. The commercial side of the business was very considerable, and it was capable of large developments. He concluded his report by saying that the board of the company ought to be remodelled. The Messrs. Fullers, whose interests were bound up with the company, had agreed that their own personal positions should not stand in the way of anything that was likely to arise for the benefit of the business. After mature consideration a board of directors had been proposed which he (Sir Arthur Whinney) considered was ideal. A works director was required, and a very influential and important person had been secured. That was Mr. W. L. Topple, who was for many years with Messrs. Vickers, and came to Fullers with the highest possible credentials from Sir Trevor Dawson. It was proposed that Mr. Palmer should become the managing director, while Mr. Leonard Fuller, who was occupied very largely with inventions, would be asked to take a seat on the board. Mr. F. J. Gordon, who had hitherto dealt with the sales side of the company, would also be a director while Mr. C. H. Whaite would be the financial director. Finally, as chairman of the company, they would have Mr. F. R. Wade. Mr. Fuller, Senior, was standing aside. They did not want him to go altogether, and he was the gentleman responsible for the building up of the business. His name was a household word in the trade, and it was proposed that he should remain with the company in a consultative capacity so long as his services could be made use of. In concluding, Sir Arthur Whinney said there was a prospect of future prosperity in sight.

The representative of Messrs. James Ferguson & Sons, Ltd., inquired whether the income debenture stock to be issued to the creditors would be a marketable security.

The Chairman: That is a fervent hope.

The creditor next inquired whether a Stock Exchange quotation could be obtained, and whether any modification could be made in the scheme. Would the stock, he asked, be of any value?

The Chairman replied they could only hope the stock would be of value, and no modification of the scheme could be considered. In view of the circumstances the scheme was a good one. From his knowledge of the trade he had no hesitation in saying that they had practically no alternative but to accept the scheme as the only possible means of getting something out of nothing. He proposed a resolution expressing approval of the scheme.

The representative of Messrs. J. Glickstein & Co. seconded the motion, which was carried by a large majority, there being only one creditor voting against the motion. It was announced that the short-term note holders had previously approved of the scheme, the voting in its favour being £15,525, while only note-holders for £8,950 voted against it.

Williams & Laming, electric fittings factors, Great Portland Street, London, W.—A meeting of the creditors of the above was held recently at the offices of Messrs. C. Travis and Co., C.A., Moorgate Station Chambers, E.C. In the circular calling the meeting it was stated that, acting upon the advice of the principal creditors, the debtors had decided to cease trading, and had jointly entered into a deed of assignment, the trustee being Mr. Dutchman. The latter reported that the liabilities amounted to £956, of which £242 was for cash advanced. The assets totalled £372, or a deficiency of £593. The assets consisted of furniture, fixtures and fittings, £37; stock, £124; and book debts, £210. The business had been carried on by the debtors for about ten months, and during that time the turnover had been rather more than £1,500. The purchases had been a little short of that figure, and it appeared that the business had been carried on at a loss. The debtors had each drawn about £4 a week.

A resolution was passed in favour of the meeting being adjourned, and the opinion was expressed that the debtors should make an effort to bring forward a proposal for the payment of a composition of not less than 10s. in the £.

Bankruptcy Proceedings.—*Re* E. W. Morgan, company director and electrical engineer, Eccles Mill, Monton Lane, Eccles.—With reference to the notice appearing in the Electrical Review, November 3rd, p. 625, regarding this matter, the Ironclad Switchgear Co., Ltd., of the same address, write stating that this bankruptcy has no connection with that company.

J. R. Gough, electrician, 79, Prospect Road, Scarborough.—Receiving order made November 6th on debtor's own petition.

Company Liquidations.—Modern Electrical Supply Co., Ltd.—Winding up voluntarily. Liquidator: Mr. R. Stephens, 31, Lombard Street, E.C.

The "Watt" Electrical Co., Ltd.—Voluntary liquidation. Mr. H. Gardiner, Palmerston House, London, E.C.2, liquidator. Creditors to send particulars of debts, &c., by December 6th. Meeting of creditors, November 23rd, at Institute of Chartered Accountants, Moorgate Street, London, E.C.2.

Weldrics, Ltd.—Meeting of creditors, November 22nd, at 34, Nicholas Lane, E.C.4. Liquidator: Mr. R. R. Callingham.

Dissolutions of Partnership.—R. W. E. Braham & Co., manufacturers of electrical and gas fittings and general spinners, 21, Bowling Green Lane, Clerkenwell, E.C.—Messrs. R. W. E. Braham and A. E. Hodgson have dissolved partnership. Debts will be attended to by Mr. Hodgson, who will continue the business under the same style.

Ash & Fraser, sanitary and electrical engineers, Belmont Street, Monton, 51, Barrfield Road, Pendleton, and 21, Anson Street, Monton, Lancs.—Messrs. J. H. Fraser and J. W. Ash have dissolved partnership. Mr. Ash will attend to debts at Belmont Street, Monton.

Clampett & Jones, electrical engineers, 13a, Paton Street, Manchester.—Mr. R. H. Clampett and Mr. E. M. Jones have dissolved partnership. Debts will be attended to by Mr. E. Williams, 12, Cleveley's Avenue, Chorlton-cum-Hardy, Manchester.

Caerphilly & District Engineering Co.—Electrical and sanitary engineers, 71, Cardiff Road, Caerphilly, The Square, Senghenydd, and Pandy Road, Bedwas.—Mr. J. H. Miles and Mr. F. D. Zussen have dissolved partnership. Mr. J. H. Miles will attend to the debts of the electrical branch and carry on that side of the business at The Square, Senghenydd. The debts due to and owing by the sanitary and plumbing department will be attended to by Mr. F. D. Zussen, who will continue the sanitary and plumbing department at 71, Cardiff Road, Caerphilly.

Trade Announcements.—The London office of Messrs. G. D. Peters & Co., Ltd., has been transferred to Caxton House, Tothill Street, Westminster, S.W.1. The Consolidated Brake and Engineering Co., Ltd., of 15, Dean's Yard, Westminster, and the British Air Brake Co., Ltd., of 64, Victoria Street, Westminster—companies of which Messrs. Peters are the sole proprietors—are also transferring their offices to the same address. Telephone: Victoria 2900/1; telegrams: "Peters, Vic., London"; cables: "Peters, London."

Messrs. J. & A. Anderson, 231, St. Vincent Street, Glasgow, have been appointed distributing agents for Scotland by the Holland Insulated Wire and Cable Works, of Amsterdam. Messrs. John McCurdy & Co., 7, Waring Street, Belfast, will represent the company in the North-Eastern counties of Ireland. Both firms will hold stocks.

Messrs. Donovan & Co. have appointed Mr. David Alexander, of 43, Mains Street, Waterloo Street, Glasgow, as their agent in Scotland for ironclad switch and fusegear. He has a representative display of their "Safuse" manufactures at that address.

The Gath Electric Engineering Co., of Halifax, is removing its showrooms from Southgate to premises in Horton Street.

Mr. E. Lawson, wireless engineer, has commenced business at Imperial Buildings, Peel Square, Barnsley.

Mr. John Stone, electrical engineer and lighting specialist, has opened premises at 2, Bank Street, Maidstone.

The counting house and general offices of Pope's Electric Lamp Co., Ltd., have been removed from Hythe Road, Willesden, to the sales department, Elasta House, 5, Arthur Street, New Oxford Street, W.C.2, to which address all communications should be forwarded.

Catalogues and Lists.—Messrs. Richson & Co., 114, New Oxford Street, W.1.—An album of electric lighting fitting designs, including silhouette shades, silk shades, table and floor standards, &c.

Messrs. John Muir & Son, Beith, Scotland.—A series of pamphlets describing a specially-designed hub for taking up road-shock and vibration in vehicles.

The English Electric Co., Ltd., Queen's House, Kingsway, W.C.2.—Publication No. 374, containing a good selection of views of power-house and sub-station switchgear of many types.

The A. & A. Electrical Co., Ltd., 13, Farringdon Road, E.C.1.—Lists A.101-2-3, giving illustrations and particulars of two- and three-phase induction motors made in Holland.

Mr. E. J. Cooke, Trinity Belting Works, Texoland, Manchester.—A price list of raw-hide mallets, hide-faced hammers, belt fasteners, machine banding, &c.

The Midland Electric Manufacturing Co., Ltd., Barford Street, Birmingham.—An illustrated and priced leaflet, giving a full description of the "Glasgow-Premier" switch.

The Runbaken Magneto Co., Ltd., Derby Street, Manchester.—An illustrated booklet describing the Runbaken magnetic petrol gauge.

The Wardle Engineering Co., Ltd., Elsinore Road, Old Trafford, Manchester.—An illustrated and priced catalogue (60 pp.) of lanterns and reflectors for industrial, street, and house lighting.

Michell Bearings, Ltd., 3, Central Buildings, Westminster, S.W.1.—A detailed description of the Michell viscometer for testing oils, fats, varnishes, &c.

Messrs. D. H. Bonella & Son, Ltd., 58 and 60, Mortimer Street, W.1.—A comprehensive catalogue of automobile accessories, including lighting fittings, switches, instruments, lamps, flexibles, &c. Priced.

The General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.—Catalogue, Section P.7, dealing with electric lighting sets for farms and country houses. Notes on erection and particulars of accessories are included. Priced.

Messrs. Ward & Goldstone, Ltd., Frederick Road, Pendleton, Manchester.—A priced sheet advertising small electric lamps in various shapes—birds, fruit, flowers, &c.—for decoration purposes.

Messrs. Strode & Co., Ltd., 48, Osnaburgh Street, N.W.1.—A well-illustrated and priced catalogue of lighting fittings of all types, including bowls, standards, brackets, lanterns, electroliers, &c.

Newcastle Electrical Contractors.—The President of the Electrical Contractors' Association, Mr. H. Marryat, M.I.E.E., visited the Newcastle branch of the Association on November 9th. In an address to the members he pointed out that the Association was now defining a clearly cut policy as regarded trading, and if the various branches would attend their meetings regularly and elect suitable representatives and support these representatives when elected, there would be no fear as to the electrical contractor keeping hold of the retail business. Mr. Marryat also dealt with labour matters and various other subjects interesting to the members.

After the meeting, Mr. Marryat and Mr. W. F. T. Pinkney, A.M.I.E.E., were entertained to lunch at the County Hotel by members of the Branch, and a silver coffee service was presented to the hon. secretary by the chairman.

After lunch, Mr. Marryat was taken by the chairman and some of the members round the various showrooms in the City, and he expressed his surprise and appreciation of the efforts that were being made in this district to place before the public the uses of electricity. Later in the day, Mr. Marryat took the chair at a meeting at the Connaught Hall, where Mr. Angus Watson, J.P., gave a paper on "Salesmanship."

Electrolytic Copper in Spain.—It is announced that the Sociedad Espanola de Construcciones Electro-Mecanicas, which was formed some time ago for the production of electrolytic copper, brass and other alloys of copper, and of copper wire, sheets, bars, tubes, &c., will begin manufacturing in the early part of next year.

Queensland Electrical Employers.—The Electrical Employers' Association of Queensland has sent us its report for the year ended July 31st, 1922. This shows an increase in membership, an income of £84 and an expenditure of £73. The Association is very active in apprenticeship, and the examination of employés as to their fitness for the industry.

Our Foreign Trade.—October Figures.—The following were the values of imports and exports of electrical goods and machinery during October, 1922:—

	Oct., 1922.		Inc. or dec.		Inc. or dec. 10 months, 1922.
Imports.	£		£		£
Electrical goods and apparatus	172,554	+	67,530	–	503,214
Machinery	683,317	+	142,894	–	2,892,224
Exports.					
Electrical goods and apparatus	702,225	–	191,971	–	5,439,204
Machinery	4,561,481	–	1,186,169	–	20,978,681
Re-exports.					
Electrical goods and apparatus	7,137	–	3,996	–	56,307
Machinery	132,277	+	32,535	–	151,546

Australian Tariff Decisions. — The following tariff decisions have been approved by the Customs Department:—Iron and Steel.—Bars, steel, hexagon and square, for use in manufacture of bright bolts, nuts, screws, engineers' set screws, and similar goods: Item 404, free under the British preferential tariff, free under the intermediate tariff, 10 per cent. under the general tariff. Boilers, marine type, water tube, having 6,121 sq. ft. heating surface, but not including superheaters, automatic chain grate stokers, or economisers: Item 174, free, 5 per cent., 10 per cent. Circuit breakers, 400 A, 37,000 V, outdoor type oil circuit breakers, for transformers and substations, with necessary control panels: Item 174, free, 5 per cent., 10 per cent. Frequency changer and transformer, 5,000 kW capacity: Item 174, free, 5 per cent., 10 per cent. Transformers, 5,200 kVA, 6,600-33,000 V, 50 period, step-up outdoor type, single-phase, oil-insulated, water-cooled, with oil and necessary parts: Item 174, free, 5 per cent., 10 per cent.—*Reuter's Trade Service* (Melbourne).

Social Events.—The staff and friends of Messrs. Duram, Ltd., held a whist drive and social evening on November 4th at Jones's Restaurant, W.1, and a very enjoyable evening was spent. Mr. W. H. Hood officiated as M.C., and refreshments were served during the interval. Prizes were provided by the directors of the company.

An interesting function was held at the Engineers' Club on November 4th, when a re-union dinner of men who worked together as apprentices with Ronald A Scott in the 'eighties took place. Mr. Newton Russell (Shoreditch), formerly chief engineer, and Mr. H. Sadd, formerly foreman, were also present. The "boys" present included A. B. Lillywhite, C. F. Jackson, F. N. Haward, C. E. D. Talbot (B.T.H. Co.), W. E. Toy (Toy & Winslow), R. H. Orbell (Newtons, Taunton), W. C. Thomson (Gt. Northern Railway), W. M. Rogerson (Halifax), F. Armfield, Hastings Squire (Chelsea), E. Paterson, J. R. Smith (Hall & Hall), and H. Marryat (Marryat & Place). The last-named will be glad to hear from other old boys.

The British Insulated and Helsby Cables Staff Guild last week held its annual tea and concert in the Britannia Rooms, Cunard Buildings, Liverpool.

For Sale.—The City of London Corporation is inviting offers for surplus generating plant at the Mental Hospital, Dartford, consisting of one 150-b.h.p. Diesel engine coupled to a 200/220-V Lancashire Dynamo Co.'s generator, with air compressor, water cooler, &c.

Peterborough Corporation electricity department has for disposal one 500-kW Willans-Siemens d.c. turbo-generator and condenser, fan, pumps, &c.

Re Bell Battery Co., Ltd.—Mr. F. M. Wilcock, receiver and manager for the debenture holders, is inviting offers for the goodwill and business and other assets of the company, including book debts.

The City of Birmingham Gas Department invites offers for two 100-kW B.T.H. turbo-alternators, with exciters, &c.; also l.p. switchboard and Tirrill regulators. (See our advertisement pages to-day.)

Swiss Interests in Peru.—A Swiss syndicate to which belong, among others, the "Columbus," a company for electrical enterprises, and the "Motor," both of Baden (Switzerland), two Swiss banks, and the Banco Italiano (in Lima), have taken over a large block of priority shares of the Lima, Light, Power & Tramways Co. The company intends to bring its plant up to date and to extend it. The electrical machinery and apparatus will be supplied by Brown, Boveri and Co., Baden, while the plans and contracting for the hydraulic and transmission plants will be in the hands of the "Motor" concern.—*Reuter's Trade Service* (Zurich).

An Opportunity Seized.—Mr. L. L. Robinson, the borough electrical engineer of Hackney, informs us that an opportunity presented itself during the General Election to "push" electricity. A screen measuring 10 ft. x 12 ft. was erected over the gates of the Hackney Town Hall, and as the results arrived from the various constituencies they were thrown upon the screen. To fill in the intervals between announcements, films and slides provided by the E.D.A. were exhibited. The publicity work of the electricity department is resulting in an overwhelming rush of applications.

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Book Notices.—" Science Abstracts, A & B." Vol. XXV. No. 297. Part 9. September 30th, 1922. Price 2s. 6d. net each.

" The *Journal* of the South African Institution of Engineers," Vol. XXI, No. 3. October, 1922. Johannesburg: The Institution. Price 2s.—This issue contains papers on " Waste Rock as a Profit Factor," by W. A. Quince; and " The Vaal River Scheme, with special reference to the Barrage," by W. Ingham, M.Inst.C.E. A list of recent South African patents is also published.

" The *Bulletin* of the Hydro-Electric Power Commission of Ontario." September, 1922.—Articles upon the Galt municipal transformer station, " Locating a Fault in an Underground Cable," " The Corona Voltmeter," and many news items are included in this issue.

The following publications have been received from the Bureau of Standards, U.S. Department of Commerce. They are obtainable from the Government Printing Office, Washington, at the prices given in parentheses:—Scientific Papers, No. 445, " A Piezo-Electric Method for the Instantaneous Measurement of High Pressures " (5 cents); No. 446, " Spectrophotoelectrical Sensitivity of Argentite " (5 cents); and No. 449, " Radio-Frequency Amplifiers " (5 cents). Circulars No. 24, " Publications of the Bureau of Standards "; and No. 134, " U.S. Government Specification for Fire-Extinguishing Liquid (Carbon Tetrachloride Base)." Technologic Paper No. 216, " Properties of Electrical Insulating Materials of the Laminated Phenol-Methylene Type " (30 cents).

" The A.C.E.C. *Revue*," October-December, 1922. London: Ateliers de Constructions Electriques de Charleroi. This issue, which is in French, is devoted to articles on high-pressure cables, the application of electricity to rolling mills, centrifugal pumps, and a set of conditions drawn up by the Belgian Electrotechnical Committee to which insulated wires and cables must conform.

New Spanish Companies.—With the designation of Saltos del Rio Ondarro, and a capital of 1,450,000 pesetas, a company has been established at Jemein (Vizcaya) for the production of light and power.

There has been embodied at Barcelona, La Energia Industrial, for electro-mechanical manufacture, installation, and representation. Capital, 500,000 pesetas.

Local Exhibitions.—The recent exhibition was a great step forward in the history of Douglas. It is 26 years since a deputation from the Corporation visited the Continent to inspect electrical systems, but, for financial reasons, the Council was not able to go forward. Matters are now well in hand, however, and it will be possible to provide current by next July. Many well-known firms took advantage of the opportunity by exhibiting splendid selections of their wares. On the stand of the Douglas Corporation were shown various types of lamps. The Carron Company gave daily demonstrations of electric cooking. One of the brightest stands was that of the General Electric Co. Here were heating appliances and electric motors, together with Witton-Kramer electrical tools and country-house lighting sets. Messrs. Seddon & Co., of Manchester, had a display of lighting apparatus, and at Mr. J. H. Blackburn's (Bolton) stand demonstrations in ironing and cooking were given. No less enterprising were the local firms, including Lawton & Co., T. W. Broadbent, A. V. Bellamy & Co., Christian & Shaw, and J. C. Fargher & Co. All these firms have already equipped private establishments with lighting plants, &c. The price of electricity has been fixed definitely at 10d. per unit from sunset to midnight and 2½d. per unit from midnight to sunset the following day. It is estimated that the cost of installations in ordinary premises will not exceed 37s. 6d. per point, including plain fittings. Mr. Bertram Kelly, A.M.I.E.E., of Douglas, has been appointed borough electrical engineer, and Messrs. Creer Bros., of Douglas, have secured the contract for the building of the new electricity works.

A successful electrical exhibition was held from November 2nd to 11th, at Warrington. The organisers were the Electricity and Tramways Committee and local members of the Electrical Contractors' Association. The show was opened by Sir Peter Rylands, who said that electricity was gradually superseding other forms of power, and an exhibition of this nature would show the public what could be done by its aid.

A number of the leading electrical firms participated in the exhibition, one of the most prominent being the St. Helens Cable & Rubber Co., Ltd. Mr. J. H. C. Brooking, of this firm, was the hon. secretary to the organising committee. The firm showed wires and cables of all sizes and samples of insulating materials. The Economic Electric Co. displayed wireless apparatus, lighting plants, and domestic appliances. Messrs. Etchells, Congdon, & Muir, Ltd., showed a model automatic lift, and lift accessories. Messrs. Wright Motors, Ltd., exhibited samples of their manufactures. Carron Company and the Falkirk Iron Co., Ltd., represented electrical cooking with appliances of many types and sizes. Messrs Evershed & Vignoles, Ltd., showed, through their Northern agents, Messrs. Jessop & Boydell, Ltd., a range of their instruments including the " Meg " insulation tester, voltmeter and ammeters. Mr. George Ellison had examples of industrial switchgear on view. Messrs. Harry Bibby & Co., local electrical contractors, occupied a large space and showed representative appliances made by many firms. Other local firms which took part were the Warrington Electrical Co., Ltd., Messrs. C. H. & J. Dawson, Ltd., and Messrs. Hanson & Edwards, Ltd. (welding plant). Messrs. Veritys, Ltd., the British Electric Transformer Co., Ltd., Hotpoint Electric Appliances, Ltd., and Messrs. Parmiter, Hope, & Sugden, Ltd., also had stands. A Scots Guards' orchestra provided music during the exhibition.

The members of the management committee were Messrs. C. J. D. Barlow, A.M.I.E.E., F. V. L. Mathias, M.I.E.E. (borough electrical engineer), H. Horrocks, A. L. Madden, B. Nadin, G. A. Platt, H. Evans, and Ewart Watson.

Openings in Northern Ontario.—H.M. Trade Commissioner at Toronto (Mr. F. W. Field) has furnished to the Department of Overseas Trade a report in which he states that there is a good demand in Northern Ontario for mining machinery and supplies (estimated at a value of $20,000,000/$30,000,000) including the following: electrical material and equipment; air compressors; rock drills; pumps, hoists, skips, cages, &c.; boilers, steam plant, steam engines, &c.; labour-saving machinery for lifting and dumping; and storage battery locomotives for underground work. It is believed that British firms may, with advantage, review their agency arrangements with a view to obtaining a greater volume of business in the northern section of this area. Several United States firms pay small retaining fees to local representatives in Northern Ontario whether or not any great volume of business is being obtained at the time. United Kingdom manufacturers should warehouse a fairly substantial supply at Montreal or Toronto for the Northern Ontario market, and it is recommended that British firms' catalogues and other trade literature containing details should be circulated in this area. Buyers insist on having descriptive catalogues containing particulars as to dimensions, and, as one buyer stated, " Telling the whole story." A list of some of the principal purchasing agents in Northern Ontario to whom the Trade Commissioner recommends that catalogues, &c., should be sent can be obtained by interested United Kingdom firms on application to the Department of Overseas Trade.

Belgian Offer to Budapest.—It is reported from Budapest that M. Bettern, president of the Belgian Electricity Trust, has made a proposal to the municipal council of that city, offering to take over the municipal supply works and the tramways. The Belgian financial group offers as payment for the transfer the sum of 25,000,000 Belgian francs, corresponding to 4½ milliards of Hungarian crowns.

Applications for British Trade Marks.—Appended is a summary of the recent applications for British trade marks in respect of goods and productions connected with the electrical trades and industries. Firms desiring to enter an objection to any of the applications have one month in which to do so from the dates mentioned below.

Calite. No. 426,997. Class 5.—Unwrought and partly-wrought metals used in manufacture. British Thomson-Houston Co., Ltd., Crown House, Aldwych, London, W.C. November 8th, 1922.

Electromophon (lettering and design). No. 426,571. Class 8.—Electric gramophones. Purcar, Ltd., 18, Prudential Buildings, Portsmouth. November 8th, 1922.

Fellocryst. No. 428,765. Class 8.—Wireless communication apparatus. Fellows Magneto Co., Ltd., Cumberland Avenue, Park Royal, London, N.W. November 8th, 1922.

Reako, London (lettering and design). No. 425,162. Class 13.—Metal goods. Russell Electrical Appliances Co., 60, Queen Victoria Street, London, E.C. November 8th, 1922.

Price Reductions.—The Jackson Electric Stove Co., Ltd., announces that the prices of certain of its cookers have been reduced, and, in addition, a number of improvements have been effected enhancing the appearance of the appliances.

Messrs. Bastian & Allen announce a reduction in prices of Bastian Quartzalite heating elements. A new catalogue is in preparation.

An Engineers' Guild.—The November *Journal* of the Amalgamated Engineering Union contains an account of the formation of The Guild of Engineers (London), Ltd. This is a co-operative undertaking organised by the London branches of the Union, with the participation of any other trade union or group of engineering workers, to carry out public contracts. It is stated that the Guild has already received an order to carry out a boiler installation for the Camberwell Borough Council's public baths. The Guild has been successful in securing the support of several members of the Institutions of Civil, Mechanical, and Electrical Engineers, and the name of Mr. C. Ashmore Baker, A.M.I.E.E., is mentioned in this connection.

Proposed International Exhibition at Sofia.—On the occasion of the fiftieth anniversary of the independence of Bulgaria, the Government proposes to submit a bill to the Sobranjé for the organisation of an international exhibition at Sofia, in 1928. A commission of technical experts will shortly be appointed to elaborate with the assistance of the Ministries of Public Instruction and Commerce and Industry the details of the scheme. The State, the Chambers of Commerce, and the provincial and municipal councils will introduce credits in their budgets each year up to 1928, in order to help to cover the cost of the organisation of the exhibition.—*Reuter's Trade Service* (Sofia).

Defections from Trade Unions.—The quarterly report of the General Federation of Trade Unions states that the Unions are still losing members, although it is considered that the loss is not so bad as would appear from the figures. The report points to the fact that countries whose currency is comparatively stable have more unemployed than those whose currency has collapsed. This is attributed to the fact that the latter become "sellers" instead of "buyers," with resultant injury to the financially stable countries. The financial position of the Federation is declared to be sound, a reserve of £65,339 being disclosed after meeting all claims.

The British Empire Exhibition.—We learn that the B.E.A.M.A. has made considerable progress with the organisation of the Electrical and Allied Engineering Section of the British Empire Exhibition. There is about 120,000 sq. ft. of space to be let, and something like half the space has already been booked. We wish to draw the attention of all makers of electrical machinery and appliances of whatever kind, including manufacturers of wireless appliances, to the exhibition. An invitation is extended to all to exhibit in the section and thus ensure that the electrical industry will be adequately represented at this great exhibition. Applications for space should be made to the British Electrical & Allied Manufacturers' Association, 36 and 38, Kingsway, W.C.2, and it is specially desired that application should be made without delay, as it is hoped to have the bookings fairly complete by the end of the year in order that the final plans for the buildings for this section can be passed. The members of the B.E.A.M.A. have already done a great deal towards making this section of the exhibition a success, for, in addition to taking the bulk of the exhibition space already booked, they have arranged to loan to the exhibition at a purely nominal rental the whole plant and accessories, having a capital value of approximately £130,000, for the temporary power station which will be installed in the exhibition building itself and form an attractive feature of the section. As already stated, the Association is also organising a world power conference, which is to be held during the exhibition in the lecture halls which are being provided. This conference has already received the support of Government departments and representatives of overseas Governments in this country, and of many distinguished representatives of science and industry throughout the world. In the United States, for example, it is receiving the consideration of the Federal Power Commission, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the Electrical Manufacturers' Council, the National Electric Light Association, and the Power Club. In Norway it is being supported by the Norwegian Water-power and Electricity Board, and the chief director of the Board is giving the matter his personal attention. In Sweden the question is being taken up by the Swedish Technological Association, the Royal Swedish Academy of Engineering Science, the Federation of Swedish Industries, the Swedish Water-Power Association, and the Royal Swedish Water Board. On such lines as these the interests of the conference are being advanced in France, Italy, Denmark, Holland, and other countries, and national committees are in process of formation, which will consider how much of a wide and comprehensive programme can effectively be undertaken at Wembley in 1924.

Mr. John Campbell, late of the United Provinces Civil Service, has been appointed secretary to the Indian and Burma Advisory Committees for the Exhibition by the Government of India.

British Industry and the Canadian Market.—The Federation of British Industries has decided to inaugurate a British Section at the next Canadian National Exhibition, to be held at Toronto next year. The question of trade with Canada is of the utmost importance at the present time, for more than one reason. As a result, considerable interest is being manifested in the Canadian National Exhibition, one of the most important trade gatherings of its kind held in the world. It is hoped that next year there will be a million and a half visitors. The exhibition is held for a fortnight at the latter end of August. Although a few British manufacturers have for many years been in the habit of exhibiting at the exhibition with marked success, the bulk of the manufactured goods exhibited have been either of Canadian or American origin, and it is felt that the participation of United Kingdom firms should be very much greater in view of the opportunities for British business in Canada which exist at the present time. It is with this aim in view that the F.B.I. has decided to start a British Section. Realising, moreover, that one of the obstacles confronting British firms is the distance from England to Canada, and the expense and trouble necessitated in arranging an individual exhibit, a scheme has been prepared in which the Federation will undertake all the preliminary work and trouble of arranging exhibits.

An adequate block of space in one of the principal buildings is being held at the Federation's option by the exhibition authorities, and on this block it is proposed to erect a group of stalls to be placed at the disposal of British firms at advantageous terms. An expert staff from the Federation's Head Office will go to Canada some time before the commencement of the fair to undertake this work, and will erect the stalls, receive, unpack and arrange exhibitors' samples and arrange also, where desired, for expert representation of any firm during the run of the exhibition. For this a fixed inclusive rate will be charged, and firms will be relieved of the considerable trouble and heavy expense of sending a representative of their own to arrange the exhibit. A further advantage will be the offer of small and inexpensive spaces to firms unwilling to incur the expense of a complete stall. The grouping together of British exhibits will give importance and weight to even a small exhibit which it would not possess if merely placed haphazard along with other and larger displays. In the centre of the section will be placed a Federation stall which will act as a general headquarters and information bureau for visitors interested in British products. It is necessary, of course, if the "collective" exhibit is arranged that it should be well supported. A section that is too small to have an impressive effect will hardly be worth undertaking, but trade conditions generally, and the prospects of business with Canada, are such that it is hoped a great number of firms will avail themselves of this opportunity of attacking the market.

Wages of Fitters.—At a meeting of the No. 2 District Council for the Electricity Supply Industry, on November 8th, a letter was read from the manager of the Sheffield Corporation Electric Supply Department stating that he had received a complaint that the wages of skilled men in the engineering trades were less than those paid to semi-skilled and unskilled workers in the electricity supply industry. He asked that the anomaly might be removed. After consideration, the Employers' side agreed to consider amending the rate if the Trade Union side was willing to consider, as anomalies, the rates being paid to electrical fitters, electricians or electrical wiremen, and telephone electricians or linesmen (which are at present governed by the National Contracting Council). The Trade Union agreed to this course and the matter was put down for consideration at the next meeting of the District Council.

German Trade with South Africa.—The resumption of activity by the German Consuls in South Africa has been followed by the forwarding to Berlin by the Consulate at Pretoria of a report dealing with the question of direct or indirect trading with that part of the British Empire, as seen from the German point of view.

The report states that if direct sales are attempted it is necessary for the German exporters to keep in mind the fact that English goods, tastes and styles still predominate in South Africa, and it is, therefore, desirable for English market conditions to be studied first before thinking of undertaking direct business with the Dominion. Firms who usually avail themselves of the services of export houses for transmarine business are also recommended to follow the English and American example and make direct and regular offers in the South African market, as this often leads to transactions being entered into. Offers are to be accompanied, the report states, by the notice: "Orders solicited through European Export Houses," and by patterns and samples, where possible. The catalogues and prices f.o.b. port of shipment, are to be in English, and English weights and measures are to be used, but the Consulate will not undertake the distribution or forwarding of printed matter.

Coming to discuss the question of payment the report states that South African firms as a rule pay through their European buying houses or agents on presentation of the shipping documents. On the other hand, firms who are not in connection with European buying houses usually pay by means of bills which, in the case of well-established houses, are mostly discounted by the South African banks in Europe without being first sent for acceptance; and in these cases the bills are drawn at from 60 to 90 days' sight. It is added that although import firms two or three years ago were willing to pay an instalment on account of orders already placed, it is improbable that such a condition would now be agreed to, except perhaps in the case of machinery.

In conclusion, the report refers to Government orders and states that if non-British firms have representatives in South Africa, in principle they are not debarred from competing for contracts thrown open by the Government.

Commercial Arbitration.—It would be of interest to learn the precise situation of the scheme for a Court of Arbitration in connection with the International Chamber of Commerce in Paris, for the adjustment and settlement of international commercial disputes. According to the sources from which we recently quoted on the question the Court has been formed, but this appears to be somewhat premature despite the fact that the members of the Norwegian National Committee in the matter have been appointed. This assumption is based upon a statement made by Mr. A. C. Bedford, chairman of the American Section of the International Chamber of Commerce, who is reported from New York last week, to have announced that "plans have been perfected for the establishment of a Court of Arbitration," with headquarters in Paris, and independently of all Government agencies. Apparently the promoters are either unwilling to await the effects of the low-speed machinery of the League of Nations, or they believe that there is more prospect of success in the case of a private scheme.

The G.E.C. Delivery Service.—The General Electric Co., Ltd., now possesses a fleet of 18 motor and 4 horse-drawn vehicles for delivering goods in the London postal area as well as in certain districts beyond this area. There are two deliveries a day in the West End and City, one a day to most of the other places, with the exception of one or two outlying districts which are visited twice a week.

Chinese Notes.—The Ministry of Communications has recently drawn up a set of regulations laying restraints on the registration of electric light companies. One article of the regulations provides that the registration of electric light companies will be subject to cancellation if actual erection of the plant is not commenced within a period of three months dating from the grant of registration.

Mr. Chow Kai Tsing and others plan to organise the Ta-Ming Electric Co. in Nantungchow, with a capital of $400,000.

The Yeh Chung Machine Co. has been organised by C. C. Nieh and other prominent merchants of Shanghai. Its main business is to manufacture electrical materials and machines. Its factory site is at Yang Ching Chiang Pootung.

LIGHTING AND POWER NOTES.

Abertillery.—Electricity in Bulk.—Arrangements have been made to obtain electricity in bulk from the Ebbw Vale Co., and it is anticipated that the centre of the town will be lit by electricity by Christmas.

Australia.—Western Australia.—The earnings of the Government electricity supply undertaking for the year ended June 30th last amounted to £118,775, as compared with £92,312 in the preceding year. Working expenses rose from £74,978 to £87,582, leaving a gross surplus of £31,193, as against £17,334. Interest and depreciation charges absorbed £31,759 (£26,894), resulting in a net deficit of £566, as compared with £9,560. The amount of energy sold increased from 22,596,330 to 27,105,309 kWh. The average price obtained rose from 0.973d. to 1.05d. The plant capacity remained at 12,000 kW.

New South Wales.—The Blue Mountains Shire Council proposes to raise a loan with a view to extending the electric lighting system from Woodford, so as to include Faulconbridge, Springwood, and Valley Heights.

Rockhampton (Queensland).—The City Council proposes to borrow £100,000 for various purposes, including an electricity supply scheme.

Maryborough (Victoria).—The Town Council is floating a loan of £15,000 with a view to providing electricity for lighting and power purposes in the town.

Cardiff (N.S.W.).—Steps are being taken to obtain a supply of electricity for the town, and the Newcastle Council has been asked to extend its system to serve the district.

Billericay.—Electricity Supply.—The Rural Council has consented to applications for Orders to supply electricity in the district by the Brentwood District Electric Co., Ltd., and the Wickford & District Electricity Supply Co.

Bootle.—Charges of Canal Company.—The Ministry of Transport, on October 31st, instituted an inquiry into a complaint by the Bootle Corporation that the Leeds & Liverpool Canal Co. charged excessively for the water taken from the canal by the Corporation for condensing and feed purposes. A charge of .01d. per kWh generated was fixed in 1901, and, in spite of plant improvements, the company declined to reduce it. In 1920 the Corporation received a letter intimating that an increase to .015d. per kWh was to be made as from January 1st, 1921, and under the threat of having supplies cut off the Corporation decided to apply for an Order under Section 15 of the Electricity Supply Act (1920). The company refused to accept arbitration in the matter. The Corporation contended that the company was not put to any expense through the use of the water, nor was any service required by the company in connection with it. The borough electrical engineer (Mr. T. D. Clothier) and the chairman of the Electricity Committee (Councillor James Scott) gave evidence. The company maintained that the charges were necessary and not excessive, and pointed out that the question would soon cease to trouble the Bootle Corporation. This was not a proper case for the establishment of a precedent. The Corporation admitted that it was charging more than double the pre-war price for electricity, although the charge for water had only been increased by 50 per cent.

It was intimated by Mr. Kessane, who conducted the inquiry, that an early decision would be given.

Brazil.—Hydro-Electric Scheme.—Official consent has been given to the plans submitted for the utilisation of the falls of Mambucaba, situated on the frontier-line between the States of Rio de Janeiro and Sao Paulo. It is proposed to form an influential syndicate for the purpose of installing the necessary plant and machinery to supply hydro-electric energy for a number of public services. The approval of the plan by the Government has entailed the reservation of an area of 12,300 hectares of land which can be devoted to any useful industrial purpose.—*Reuter's Trade Service.*

Cheadle and Gatley.—Loan Sanctioned.—The Urban Council has received sanction from the Electricity Commissioners to a loan of £10,000 for electricity purposes.

Chile.—Progress of Santiago Station.—So satisfactory has been the progress in the erection of the Santiago power station that completion is expected before the end of December. The work which has been carried out will enable the station to receive the 110,000-V current from the great dam and station located at Maitenes, where it will be transformed to 550 V and distributed for the lighting and street-railway services of the Chilean capital, as well as for the service of the electrified railway now being constructed between Santiago and Valparaiso.—*Reuter's Trade Service.*

Continental.—France.—The Commercial Counsellor at Paris (Mr. J. R. Cahill) reports that the French Cabinet adopted, on October 31st, a Bill for promoting by State advances, the development of electrical distribution in country districts. Under this Bill loans for periods up to thirty years are grantable by the State to communes, to unions of communes, and to authorised agricultural associations, at the rate of interest of 4 per cent., and these loans will be guaranteed by the departments in which these organisations are domiciled. The necessary funds for making advances will be obtainable from the Caisse des Depôt et Consignations, but in no year may the total lent under the scheme exceed 600 millions. It is a stipulation that the advances of the State to any recognised organisations are not to exceed the amounts raised by such organisations for the same purpose. It is, therefore, seen that the programme of electrical distribution in country districts, if advantage is taken of the State loans, will be capable of realising work representing in value a total of 1 milliard 200 millions of francs.

La Société Havraise d'Energie Electrique is erecting a 30,000-V transmission line between the generating station at Gainville and the town of Bolbec.

Rumania.—Steps are being taken to utilise the waterfalls in the Transylvania mountains for generating electricity. With this object in view a company, styled the Karpathenwerke, has been formed in Hermannstad to utilise some 125,000 h.p. of the waterfalls in the Carpathians.

Germany.—A German electricity supply company, the Kraftwerk Sachsen-Thüringen A.G., in announcing recently the raising of the price of electricity for lighting to 45 marks, and for power to 36 marks per kWh, makes known its willingness to receive payment in goods, instead of in coin or paper namely—for each kWh of lighting energy, 10 eggs or 3 lb. of wheaten flour, or a ¼ cwt. of potatoes.—*Elektrotechnischer Anzeiger.*

Czecho-Slovakia.—Steps are being taken to erect large hydro-electric power stations at Seestadtl and Kaaden. The linking up of the power stations in north-eastern Bohemia and the extension of the network of the North Bohemian Electricity Works are also in hand.

Costa Rica.—San Jose.—The municipality of San José has decided to install a new electric power plant sufficient to light the whole of the city and to supply power for several industrial establishments already erected there, and for others which are contemplated.—*Reuter's Trade Service.*

Guildford.—Extension of Supply.—Onslow Village, Ltd., has asked the Town Council for terms for extending the electricity supply to include the village. The Council has replied that it will be necessary for Onslow Village, Ltd., to guarantee £450 per annum and to bear its own service charges for laying mains.

India.—Hydro-Electric Scheme.—The hydro-electric works which was recently completed in Naini Tal was started in 1920. To-day, 17 miles of roads and streets are being electrically lighted. Most of the hotels and houses have also been connected with the distribution system. The electric power is also going to be used for driving the waterworks pumping plant. Water is taken from the lake at Naini Tal, while the main power station is situated 1,500 ft. below at Durgapore. The water is conveyed by two steel mains 2,300 yards long. The main power station is connected with three sub-stations by a transmission line, the transmission pressure being 3,300 V. The sub-stations are equipped with Westinghouse oil-cooled transformers, the necessary switchboard, &c.—*Indian Textile Journal.*

Llandrindod Wells.—Purchase of Undertaking.—A ratepayers' meeting has decided to support the Council's proposal to purchase the electric light undertaking for £22,500.

New Zealand.—Ashburton.—A poll of the ratepayers has approved of the borrowing of £296,500 for the purchase of the plant and transmission lines of the Ashburton Electric Supply Co., Ltd.

Norden.—Electricity Scheme.—The Urban District Council is suggesting to the Rochdale Corporation: (1) That the Corporation supply electricity to Norden in the same manner as it now supplies gas to agreed points on Edenfield Road and Bagslate Moor Road; (2) that the Corporation should take over the Bury Road district electric lighting; (3) that the Corporation should supply electricity in bulk to Norden, the District Council to erect a transforming station. Negotiations

are now proceeding and a report on the estimated cost of the scheme is to be prepared by the Council's electrical engineer when the Rochdale reply is received.

Pembroke (Co. Dublin).—Price Reduction.—The District Council proposes to reduce the price of electricity in its area from 10d. to 8d. per unit for lighting.

Peterborough.—Year's Working.—The accounts of the Corporation Electricity Department (engineer: Mr. H. A. Nevill) for the year ended March 31st last record a total revenue of £34,561, as compared with £25,452 in the preceding year. The working expenses absorbed £29,344, as against £22,862, leaving a gross surplus of £5,217 (£2,590). After the payment of capital charges the result was a net deficit of £6,870, which was the largest deficit yet incurred, the figure being £3,580 in 1920-21. The adverse result is attributed principally to the coal miners' strike last year. The energy sold showed a large increase, *viz.*, from 1,280,653 to 1,973,936 kWh. This increase was entirely due to bulk supply contracts; without these there would have been a decrease.

Rawdon.—Electricity Supply.—The Electrical Distribution of Yorkshire, Ltd., has agreed to supply electricity to the district, and a sub-station is to be erected at "Mawcroft."

Torrington.—Electricity Supply.—An agreement has been signed between the Corporation and Mr. S. I. Knill, of Hele Manor Park, Barnstaple, by which the latter will provide, within 18 months, a supply of electricity to the town, either as a separate undertaking or as an extension of the Bideford and District Electric Supply Co., Ltd.

Venezuela.—Hydro-Electric Resources.—It is stated that attention is to be given to the exploitation of hydro-electric resources, only the fringe of which has hitherto been touched. Abundant opportunities are believed to exist. The soil of Venezuela is watered by no fewer than 1,059 rivers and streams; a considerable number of the affluents to such rivers as the Orinoco, Apure, Leta, Caura, Negro Guarico, in addition to several waterfalls, could be successfully adapted to the supply of power. Considerable development is possible at Naiguata, 20 km. (12.43 miles) from Carácas; these falls have a drop of 1,026 metres (3,364 ft.), with a volume of 515 litres (18.18 cu. ft.) per second, and a rated effective horse-power of 4,300. It is claimed that this source of power, with slight additional cost, might be made to deliver 6,000 h.p. It is also proposed to use the waterfall of the Manzanares River to work the railway from Cumana to Cumanacoa. This line is of 1.07-m. gauge (3.51 ft.) and 60 km. (37.28 miles) in length. Foreign capitalists exploiting this enterprise and similar undertakings would probably enjoy exemption from local, State, and Government taxes.—*Reuter's Trade Service* (Caracas).

Wantage.—Electricity Supply.—The Urban Council has decided to give support to an application by Sir Charles Bright & Partners, Ltd., for an order to supply electricity to the town.

TRAMWAY AND RAILWAY NOTES.

Australia.—New South Wales.—The *Industrial Australian and Mining Standard* states that the State Railway Department is anxious to proceed with the electrification of the Sydney suburban lines, but the question of finance is causing some difficulty. The first stage is the electrification of the Illawarra line to Hurstville and the Bankstown line. The total cost of this, including locomotives, is estimated at £500,000. Power is already available, but the conversion would take about two years. Over £250,000 has already been spent in anticipation of electrification, including tunnel widening, new rolling stock, &c. It is stated that conversion would double the present traffic capacity. The Cabinet may defer the work until next year, but the view of the Railway Department is that permission to go ahead should be given immediately. If suburban railway electrification is carried out, it will probably delay the conversion of the Newcastle steam tramway system, for which £1,000,000 is required.

Melbourne.—The electric tramways operated by the Melbourne Tramways Board earned a total revenue of £600,698 last year—an increase of over £126,000. The working expenses amounted to £436,518, leaving a gross surplus of £164,180, out of which £70,285 was paid in interest on stocks and debentures. The number of passengers carried was 63,546,435, and the car-mileage increased by 740,166 to 6,178,990.

Western Australia.—The annual report upon the working of the Government tramways (year ended June 30th, 1922) shows an increase of revenue from £224,892 to £248,463. Working expenses also increased—from £204,459 to £209,104. The gross surplus was thus £39,359, as compared with £20,433. Interest charges absorbed £35,524, leaving a net profit of £3,835. In the preceding year the final result was a deficit of £9,334. The car-mileage increased from 2,552,550 to 2,644,725, and the number of passengers carried decreased from 25,753,113 to 25,042,689.

Birmingham.—Railless Cars.—The Old Square is being prepared as the starting point for the railless cars, which will run on the Nechells route. A number of these vehicles have been delivered. The date of the opening of the new service is not yet decided.

Continental.—France.—With the equipment of its lines for electrical working, the Midi Co. is proceeding with the erection of additional stations to provide the necessary power. At present its power stations have an aggregate capacity of 50,000 h.p., but the harnessing of a further 300,000 h.p. of water-power is planned, using the waters of the lakes of Artouste and Lanouse.

Italy.—A Bill has been introduced in Parliament to empower the Government to sanction the construction of the electric railway, Trieste-Cividale-Passodel Predel, which will link Trieste to Central Europe, by private enterprise. The estimated cost of carrying out the work is 500,000,000 lire.

A company has been formed at Pavia by representatives of the communes interested and of the provincial authorities of Milan, Pavia and Piacenza, for the construction and working of an electric tramway to run from Milan to Valtidone. The Milanese engineer, Croci Alfredo, is now engaged on preparing the plans.

The building of an electric railway between Gozzano and Alzo, province of Novara, to assist the granite industry of the Cave of Alzo and the district of Cusiana, is under consideration by the local authorities.

A committee has been nominated for the construction of an electric railway linking Ancona, Osimo, and Castelfidardo, and eventually Loreto, Porto Recanati, Falconara, Camerano, and Montesicuro. Application for official sanction is to be made.

Spain.—Bilbao tramwaymen have not resumed work with the other men who went on strike as a protest against the trial of four workmen accused of having murdered an employer. The whole tramway staff has been dismissed, and another general strike is threatened.—*Reuter.*

Bulgaria.—A commission of experts is now engaged in studying the question of the electrification of the Pernik-Sofia line in order to increase the output of the coal mines, and so help to meet the railways' requirements for coal. The construction of an electrical power station at Pernik is planned, which will supply electrical energy, not only to the Sofia-Pernik line, but also for lighting purposes in Sofia. The commission will shortly present its report to the Government, which will take the necessary steps for the realisation of the project.—*Reuter's Trade Service* (Sofia).

Darlington.—Light Railway.—The Town Council has agreed to the recommendation of the Electricity and Light Railways Committee that the manager shall prepare an estimate of the cost of completing Railway No. 3 to Haughton-le-Skerne, and also of extending the lines along Brinkburn Road, Feethams, and Victoria Roads.

Manchester.—New Route.—With a view to finding work for the unemployed, the Tramways Committee states that it is prepared to proceed with the construction of a tramway track along Anson Road, through Victoria Park, and along Birchfields Road.

Rochdale.—New Route.—The Town Council is recommended to sanction an application for powers to construct the new station tramway route *via* Richard Street and Maclure Road in place of the present route by the High Level Road.

TELEGRAPH AND TELEPHONE NOTES.

Canada.—Wireless Chain.—It is stated that the Dominion Government of Canada proposes to provide a chain of six radio stations extending into the Arctic circle. Five of the stations will be constructed at Forts Smith, Resolution, Simpson, Norman, and Macpherson, on the Mackenzie River and the sixth at Dawson City. The primary object of the chain is to keep Federal officials in touch with one another.—*The Times.*

Chile.—Earthquake Damage.—Severe earthquake shocks during the night of November 11-12th did much damage. The sea floor appears to have been raised considerably, and at Coquimbo the post office and radio station were destroyed. All the submarine cables along the coast were damaged, and direct communication between South and North America were completely interrupted. The cables of the All-American Cables Inc., Ltd., were interrupted below Iquique; there was much loss of life.

Germany.—Radio Telegraphy.—Since 1919, according to the *Telegraph und Fernsprech Technik*, Germany has been establishing a great radio organisation. It consists at present of a central post at Berlin; 17 provincial stations, the principal having multiple transmitters and the secondary simple transmitters; 75 receiving stations; seven meteorologic receiving stations, and two coast stations—at Norddeich and Swinemünde. The central post at Berlin comprises a transmission installation at Königswusterhausen, and a receiving installation at Zehlendorf, both controlled from the Berlin central telegraph office. The equipment at Königswusterhausen consists of one 32-kW Poulsen; one of 5/10 kW; two tube transmitters of 5/10 kW; five tube transmitters of 2×500 W; and five transmitters of 500 W. All these transmitters are furnished with separate antennæ, and can work simultaneously with distinct wave-lengths. The big tube transmitters consist mainly of 10 tubes of 1.5 kW each. For the

chief provincial posts, the transmission apparatus is separated from that of reception (by from 1 to 2 kW), and is worked on the duplex system (simultaneous transmission and reception).

Submarine Cables.—The Germans have laid since the war two submarine cables (one of three and the other of nine circuits) between that country and Sweden—from Stralsund to Malmö. But the weakness of the currents secured on these circuits was such that the exchange of correspondence was found to be impossible by the ordinary means. Improvement has, however, been achieved by the use with the receivers, both at Stralsund and Malmö, of vacuum amplifiers. At Berlin a similar extemporisation has allowed of satisfactory communication with Stockholm on one hand, and, on the other, with the most distant German cities, such as Munich, Frankfort, &c. A bridge, similar to that of Wheatstone, allows the transmission to be effected in the two directions as if on a single line.—*L'Electricité pour Tous.*

Radio Telephony.—International Conference.—The International Conference on Regulations for Radio Telephony and Telegraphy will be held in Paris, France, in January, 1923, says the *T. & T. Age.*

Broadcasting Commences.—Pending the formation of the British Broadcasting Co., which will be completed in a few days, the Broadcasting Committee has decided to commence a limited nightly programme from the London station. This will consist of two copyright news bulletins and official weather reports broadcast at 6 p.m. and 9 p.m., on a wavelength of 360 metres. The first two bulletins were to be broadcast on Tuesday evening, November 14th. Special messages indicating the progress of the General Election were to be broadcast, as received, on Wednesday and Thursday evening.

South Africa.—New Radio Station.—In a paper that was read on behalf of Col. Childs and Mr. H. E. Penrose before the South African Institute of Electrical Engineers, it was mentioned that in the case of the long-range station that is to be built in the Union, 170,000 metre-amperes (the product of the mean height of the aerial and the aerial current) was the figure decided upon as being necessary to give good commercial signals in the United Kingdom—about twice the metre-amps. of the St. Assise station. The height of the masts was to be 840 ft., and the aerial was to be suspended from 800 ft.; thus the mean height would be 0.7 of this value, *i.e.*, 170 metres, and the necessary aerial current would therefore be 1,000 amps. The provision of 24 masts would be necessary. Since the direct current flowing through an arc was 1.4 times the r.m.s. value of the aerial current, it followed that an arc would have to be built to absorb 1,440 amperes, whilst the voltage required would certainly not be less than 1,000. The input of the arc, regardless of auxiliary apparatus, would, under these circumstances, be of the order of at least 1,440 kW, whereas the input to the proposed valve transmitter would not exceed 400 kW. It was proposed to apply 360 kW to the aerial, which would develop 1,000 amps. The total aerial resistance could not, therefore, be greater than .360 ohm. Without an earth screen, the aerial current would probably be of the order of 300 amps. Valves of the order of 3½ kW had an average life of about 5,000 hours per valve, hence the maintenance cost of a whole battery of 100 valves of the Marconi glass type was of the order of 9s. per hour. In view of the high efficiency of the valve transmitter, and the further important fact that it was entirely unnecessary to install it in duplicate, the saving brought about by using this type of transmitter was apparent.

Sweden.—New Radio Station.—The Telegraph Board has decided that the new radio station for the purpose of communicating with America shall be built at Grimeton, near Varberg, as was expected. The station will be named Varbergs Radiostationer, and will be ready for service before the end of 1923.—*Reuter's Trade Service* (Stockholm).

Turkey.—Cable Reported Cut.—The daily Press announced on November 9th that the Eastern Telegraph Co.'s Constantinople cable had been cut by Kemalists at Erenkeui, on the Turkish side of the Chanak zone of the Dardanelles. An attempt to repair it was frustrated by the Nationalists. The British Government is said to be in communication with Constantinople by means of radio telegraphy. Smyrna has been cut off from direct telegraphic communication with Europe since last month.

On the 13th inst. the Constantinople cable was reported to have been restored, and to be working smoothly.

CONTRACTS OPEN AND CLOSED.

(The date given in parentheses at the end of the paragraph indicates the issue of the Electrical Review *in which the "Official Notice" appeared.)*

OPEN.

Australia.—Melbourne.—January 15th. Electricity Commissioners.—Switchgear and accessories, for the Morwell power scheme. (November 3rd.)

January 26th. H.p. steam, drain and feed piping, valves, traps, &c. (November 3rd.)

January 23rd. Melbourne Tramways Board. One 500-kW rotary converter and a 550-kVA transformer.

December 20th. Victorian Railways. One 2-ton electric hoist.*

Barnes. — November 27th. Electricity Department. Turbo-alternator, with surface condenser and auxiliaries, rotary converter and transformer, h. and l.p. switchgear and connections. (November 10th.)

Burton-on-Trent.—November 20th. Board of Guardians. Electric light installation, Imbecile Block. Mr. H. S. Askew, clerk.

Dundee.—November 24th. Electricity Department. Two-core and three-core l.p. paper-insulated, lead-covered, and steel-tape-armoured cable. (November 10th.)

One 15-ton hand-operated overhead travelling crane at Craigie sub-station, Dundee. Mr. D. H. Bishop, general manager and engineer.

Edinburgh.—December 4th. Electricity Supply Department. One 500-kW converting set. (See this issue.)

India.—November 9th. Great Indian and Peninsular Railway Co. Electrification of Bombay suburban lines: Electrical equipment of coaches, overhead equipment of permanent way, and overhead distribution lines. (See this issue.)

London.—St. Marylebone.—November 29th. Electricity Department. Turbo-alternator and condensing plant, water-tube boilers, fan-draught water-cooling tower, and rotary converter plant. (November 3rd.)

Paddington.—November 20th. G.W. Railway Co. Stores for six months, including telegraph instruments, electrical apparatus, electric wires and cables, electric lamps, &c. (November 10th.)

St. George's-in-the-East, E.1.—November 23rd. Board of Guardians. Installation of electric lighting at the Green Street (Upton Park) Schools. (November 10th.)

Manchester.—December 4th. Electricity Committee. Two 2,500-kW, one 1,500-kW, and one 1,000-kW rotary converters, with static transformers; or, alternatively, motor converters, with switchgear, l.p. transformer, &c. Four 500-kW automatically-controlled rotary converters and static transformers; or, alternatively, motor converters, complete with the necessary switchgear and full automatic equipment. (See this issue.)

New Zealand.—Wellington.—January 9th, 1923. Five sets of 11,000-V sub-station switchgear, for the Mangahao power scheme. Two sets 11,000-V sub-station switchgear, for the Lake Coleridge power scheme.*

Carterton.—November 20th. Wairarapa Electricity Power Board. Switchgear, lightning arresters, &c.*

South Africa.—Johannesburg.—December 4th. South African Railways and Harbours Tender Board. Twelve months' supply of electric incandescent lamps.*

*A copy of the plan, specification, and conditions of tender, &c., can be inspected at the Department of Overseas Trade (Room 84), 35, Old Queen Street, S.W.1.

CLOSED.

Australia.—Sydney City Council Electricity Committee has recommended the acceptance of the tender of Messrs. Noyes Brothers for the supply of 25,000 electricity meters of English manufacture at a cost of £42,936.—*Reuter's Trade Service* (Sydney).

FORTHCOMING EVENTS.

Institution of Electrical Engineers.—Informal meeting. Monday, November 20th. At the Institution, Victoria Embankment, W.C. At 7 p.m. Discussion on "Electric Light Wiring," to be opened by Mr. F. J. Pearce.

(East-Midland Sub-Centre).—Tuesday, November 21st. At the Loughborough College. At 6.45 p.m. Paper on "Some Recent Research in Electrical Engineering," by Prof. W. Cramp.

(Scottish Centre).—Saturday, November 25th. At the Grosvenor Restaurant, Glasgow. At 7 p.m. Smoking concert.

Institution of Mechanical Engineers, Graduates' Section.—Monday, November 20th. At the Institution, Storey's Gate, S.W. At 7 p.m. Paper on "Works Management," by Mr. H. R. Hockley.

Institution of Engineers and Shipbuilders in Scotland.—Tuesday, November 21st. At the Rankine Hall, Glasgow. At 7.30 p.m. Ordinary general meeting.

Royal Society of Arts.—Wednesday, November 22nd. At John Street, Adelphi, W.C.2. At 8 p.m. Paper on "The Economy of Smoke Abatement," by Bailie W. Smith.

Nottingham Society of Engineers.—Wednesday, November 22nd. At the Welbeck Hotel. At 7.30 p.m. Paper on "Mechanical Draught for Boiler Installations," by Major S. Utting.

Chelmsford Engineering Society.—Thursday, November 23rd. At the East Anglian Institute of Agriculture. At 7 p.m. Paper on "Industrial Refrigeration and Ice-Making," by Mr. W. B. Statham.

Edinburgh Electrical Society.—Friday, November 24th. At the Philosophical Institute. At 8 p.m. Paper on "Overhead Transmission," by Mr. J. Walker.

Institution of Mechanical Engineers.—Friday, November 24th. At the Institution, Storey's Gate, S.W. At 6 p.m. Adjourned discussion on Mr. Reavell's paper on "Air Compressors."

(Graduates' Section).—Monday, November 20th. At the Institution, Storey's Gate, S.W. At 7 p.m. Paper on "Works Management," by Mr. H. R. Hockley.

Junior Institution of Engineers.—Friday, November 24th. At 39, Victoria Street, S.W. At 7.30 p.m. Lecturette, "Notes on Waterworks Plant in India," by Mr. F. E. Murrell.

Physical Society of London.—Friday, November 24th. At the Imperial College of Science, South Kensington, S.W. At 5 p.m. Ordinary meeting.

THE "ELECTRICAL REVIEW" SERVICE DEPARTMENT.

To enable us to complete replies to queries received this week we need the names of manufacturers or suppliers of :—

Ferrault resistance-heating elements.
Endura insulating varnish.
Coley generating sets.
Also any available information as to the Faborizing process for protecting metals.

NOTES.

The Great Silence and a General Election.—We are not unmindful of the fact that this issue of the Electrical Review was being prepared while other things were happening which were of momentous importance outside our own little world. While our work was in progress on Saturday morning the Bell of St. Paul's Cathedral (beneath the shadow of which, by the way, the Electrical Review has been edited during practically the entire course of its existence) began to strike the hour of eleven. Not many seconds later the sound of maroons heralded the impressive and eloquent "Silence" in memory of that vast Host of Men, blood of our blood and bone of our bone, who laid down their lives for England and for us between August, 1914, and November, 1918. The Great Metropolis of the British Empire became for two minutes silent as a city of the dead, and as we rose to stand in reverent memory, we could not resist the inrushing flood of thoughts of men in the electrical profession who to-day are missing in bodily presence, but whose sacrifice stands out as the greatest event of the entire past Fifty Years. To-day they are not forgotten. They form a victorious company in the Spiritual Realm, leaving behind to us all a duty and a responsibility which God forbid that we should leave unfulfilled or unshouldered because four years have passed. No! they are not forgotten, nor should be those they left. How can they rightly be remembered save by winning England back again to her former moral greatness and industrial prosperity, bringing food and work and peace and contentment to all? The "Silence" ended, the City went on its way softened in heart by the memory of love and sacrifice, but soon we found ourselves confronted with the actualities of life in the shape of "General Election" bills and the call to "Vote." It is not ours to exercise influence in this matter—but is there no connection between the thoughts of Armistice and supreme sacrifice for England and the re-establishment of Government on a basis which shall bring peace and prosperity to England? The result of the Election will be known as these lines come before the reader, but whatever the result, there will remain for all of us, whatever our status in life may be, the imperative call to perform faithfully our part in industry, in profession, and in all our manifold ways, helping to rebuild the broken places and to promote a spirit of unity in the nation.

"Electrical Review" Contributors.—We regret that notwithstanding the large size of this number of the Review, we have not space to spare to do full honour to the army of writers who have collaborated with us in our editorial functions. Of our late "Chief" T. E. Gatehouse, Technical Editor for so many years, what *can* we say? Everything must be summed up in the grateful recognition that his influence—making so cheerful an atmosphere in the editorial rooms—lingers with us still, and we hope that it will long do so. Then of the innumerable writers who have come to us, some quite unknown, others comparatively so, and who have lent us their assistance as they have simultaneously climbed upward in their own career until they became so engrossed with other duties that the "writing-for-the-Press" days had to end—what shall we say of these? Some of them have died in harness; some others are filling places of responsibility and influence to-day partly due, as they have not failed to recognise, to the Review having given shape, form and publicity to their ideas when they needed assistance; others in different parts of the world will remember the promises that have accompanied their handshakes on leaving these rooms to seek greater prosperity abroad, and they will as they read recall those good intentions and will, maybe, utter a sigh at the weakness of the flesh which overcomes so many when they leave the bustle of London and "settle" amid new surroundings in other climes. We desire to-day to greet all these and other contributors, correspondents and readers throughout the world who have formed a more or less personal attachment with us.

Those who have tried us know that it has always been our policy to welcome any man—young or old—known or unknown—professional or artisan—who had something to say worth saying. Nor have we tried to evade criticism from the general reader; on the contrary, we have welcomed suggestions—even gone out in search of them in our desire to provide a journal which should meet all needs as far as lay within our power. It is so to-day, as much as it ever was. Many of our readers know that the Electrical Review is a help in a hundred ways of which the man in the street would never dream.

Accident.—Charles Halifax, an Accrington Corporation fitter, was burnt on the face and hands on November 7th by an outburst of flame which occurred whilst he was working on an underground cable in Plantation Street.

Dazzling Headlight Danger.—One man was killed and two others injured owing to their motor-car running into a telegraph pole, near Derby, on November 8th. The driver was confused by the dazzling headlights of another car.—*The Times.*

British Engineering Standards Association.—The Association has issued a tentative British Standard Specification for dimensions and resistances of enamelled plain copper wire for electrical instruments and apparatus (No. 156—1922; 1s. net). In the introduction it is stated that it is recognised that the manufacture of this class of material is not sufficiently advanced to enable a complete specification to be prepared, but the Association is satisfied that this tentative specification will be of considerable benefit to both purchasers and manufacturers. The publication contains details of mechanical, chemical, thermal, and electrical tests, notes on joints and resistance, &c.

Engineering Joint Council.—The Committee that has been considering the formation of the above-named Council, to which reference has already been made in our pages, has recommended the following constitution, which has been approved by the four Institutions concerned: The Joint Council shall consist of two members of each of the Councils of the Institutions of Civil, Mechanical, and Electrical Engineers, and of Naval Architects, in the first instance; they shall be appointed annually and shall be eligible to serve for not more than four years consecutively. One of the first two appointed by each Institution shall serve for not more than two years, but shall be eligible for re-appointment for a further period of not more than four years consecutively. The chairman shall be elected annually by the Joint Council, and the secretary of the Institution represented by the chairman for the year shall act as secretary of the Joint Council; the chairman shall be chosen from the several Institutions in rotation. The Joint Council shall consider matters referred to it by the Council of any one of the constituent Institutions; it shall not initiate proposals affecting the Institutions. The first Joint Council will be constituted as follows:—

Inst.C.E.: Sir M. Fitzmaurice and Mr. W. B. Worthington.
I.Mech.E.: Capt. H. R. Sankey and Mr. W. H. Patchell.
I.E.E.: Messrs. J. S. Highfield and R. T. Smith.
I.N.A.: Two representatives to be nominated.

The "Juice."—"Hackney Guardians have asked the Electricity Department to supply electricity for an experimental period of one year at a minimum charge of 10s. per quart."—*Daily Paper.*

"Here's to the good old electricity.
Drink it down, drink it down."—*Punch.*

Electricity in Textile Mills.—In a recent lecture upon the above subject to the Blackburn Textile Society, Mr. P. P. Wheelwright, the Blackburn electrical engineer, said that the supply of power was now a specialised industry, and it was far better for manufacturers to take their electricity from a public source, rather than generate it themselves. In working out power costs manufacturers often lost sight of many items of expense. The electrification of mills could be accompanied with a minimum interruption of plant and work. Electrification not only benefitted employers and employed, but also the district and the nation at large; the last by the conservation of coal. A considerable waste of power in mechanical transmission was avoided by the use of electricity. Moreover, as the load decreased so the amount of energy taken decreased, which was not the case with mechanical drive. Then the uniformity and steadiness of the electrical method was a great advantage which had a good effect upon the quality of the product. Mr. Wheelwright emphasised the fact that the purchase of electricity from a central authority relieved the management of a mill from the worries of a thousand and one details, apart from the economies effected by the ability to measure power exactly. In addition to electrical driving the speaker drew attention to the possibilities of electrical heating. He urged greater consideration for electrical methods, pointing out that in India and other competing countries electrification was the rule rather than the exception.

The Orientation of Molecules in a Magnetic Field.—In a letter to *Nature*, Mr. Marshall Holmes, of the Sir Donald Currie Laboratories, Queen's University, Belfast, states that he has obtained experimental results indicating that the molecules of a substance undergo an orientation when placed in a magnetic field. A pencil of X-rays directed through a solution of barium iodide produces on a photographic plate an image which is more than 10 per cent. larger in diameter when exposed to the influence of a magnetic field than the image obtained without the field. The result has been corroborated by methods entirely independent of the properties of X-rays, and the matter will be further investigated.

Report on the Training of Electrical Power Engineers.—One of the principal objects of the Electrical Power Engineers' Association is to improve the training and raise the professional status of engineers engaged in the generation and distribution of electrical energy. The Association has now issued a report on this subject, dealing with the advantages of training to the various parties concerned, the objects and methods of training, proficiency tests, &c. The report, which is admirably drawn up, calls for careful consideration, and will be reviewed in an early issue.

Electric Heating in Canada.—At the moment of going to Press there reaches us from our Canadian correspondent the following information:—"A somewhat extraordinary situation has arisen in Canada, more particularly in Ontario and Quebec, owing to the serious fuel shortage created by the prolonged strike of the coal miners in the United States, which ended only a few weeks ago. It is authoritatively stated that there is no possibility of more than 60 per cent. of the normal supply of anthracite reaching Canada this winter; at the time when the strikers went back to work, Toronto, which uses about 900,000 tons of anthracite per annum, had only received about 10 per cent. of this quantity, whereas usually the proportion is very much larger by the time autumn has arrived. The situation referred to above is that, owing to electricity being comparatively cheap, the use of electric heaters, with a view to saving coal and other fuels, all of which are both scarce and dear, is growing by leaps and bounds, and it is more than probable that voltage regulation in many municipalities will be particularly bad this winter. Unfortunately, Canadian winters, except on the other side of the Rockies, are so cold that, abundant as are the water powers of the country, there is no possibility that electricity can be used on any generous scale for the heating of buildings. The following facts show this clearly:—Actual tests indicate that an average house of six or eight rooms requires not less than from 15 to 20 h.p. to heat it on very cold winter days; in Toronto there are nearly 100,000 houses, and if all these were heated electrically it is evident that from 1,500,000 to 2,000,000 h.p. would be required for heating houses alone—and this only refers to one city. Moreover, this would be purely a winter load, and the full amount would only be needed on the very cold days; on milder days much less would be required, hence the annual load factor would be low, and the problem would be to find sufficient extra power in the winter to supply other needs, even if enough could be furnished to meet the heating requirements.

"Many people here, ignorant of such facts as those cited, look joyfully forward to the time when Niagara and other of Canada's great water powers shall make this country altogether independent of the United States with regard to fuel supplies, and when (to use a phrase of which the daily papers are fond) 'the turning of a switch' will bring heat in abundance for the whole country. Notwithstanding the above, electricity during the present chilly autumn days is proving a godsend to many a home which at the present time is almost without fuel."

Fuel in Czecho-Slovakia.—By a Government ordinance, an "Institute for the Economic Use of Fuel" has been called into being, with its seat at Prague. Its operations will embrace the whole of the republic, and are defined as the systematic investigation of fuel and its places of deposit, with their development. The Institute is under the control of the Minister of Public Works, who nominates its members for three years from the localities where the Institute is operating, such members being representatives of public schools, gas works, electricity works, and sundry others.

Control of Gaseous Conduction.—In electric circuits of all sorts, power is transmitted principally by metallic conductors. In order to control the flow of power, or to convert it from one form to another, the constants of the circuits are varied. The connections of the metallic conductors may be altered for this purpose; but at high potentials this operation is attended with difficulty. The rapidity and ease of control are also limited. For this reason there has been a tendency, in recent years, toward the increased use of control devices employing non-metallic conduction, and these are now being rapidly brought to the fore. As examples we have the very versatile thermionic tube and the mercury arc rectifier. Devices employing conduction by gaseous ions have been handicapped in this general evolution by three main disabilities: the first being the difficulty of placing the discharge where wanted; the second, the tendency of the working gas to disappear; and the third, decidedly erratic action. These disabilities have recently been to a large extent removed by the advent of a principle called the "short path principle," by which discharge can be prevented except where wanted. This has also led to long life, for by placing the discharge in proximity only to certain porous materials, gaseous clean-up and disintegration are both prevented. With this change, uniformity of action also appears. By utilising this principle, gaseous conduction devices may be designed, for example, as rectifiers. Two examples are described in the A.I.E.E. *Journal* for September, 1922, the first obtaining unilateral characteristics by the use of a magnetic field, and the second by the use of a space charge. The present models, as described, are capable of handling only small amounts of power; but there is no inherent limitation in this direction. The usual conditions of cost, reliability, life, and so on, will determine development for higher powers. It is impossible to predict at present the particular portions of the electrical field in which this device in its various forms will find a use. The authors believe, however, in the possibility of constructing gaseous conduction devices which can be depended upon and which will last indefinitely. The control is so complete that a ratio of currents in two directions of several thousands to one can readily be obtained. These rectifiers will readily stand a back pressure of several thousand volts, and the current which they can pass is limited only by the possibility of getting rid of the heat evolved. The internal drop is around 200 volts with the usual arrangements of the device; heavy currents can be passed for short intervals.

One commercial model of this form of S-tube is rated at 50 milliamperes continuously, and 1,500 volts back pressure. It has a substantial continuous overload capacity. It is designed primarily for charging fire alarm batteries and for the use of radio amateurs. For convenience, it is built to be screwed into the ordinary standard lamp socket. No other appurtenances or auxiliaries are necessary, and its life is very long. The efficiency depends upon the circuit, and is high when high voltages are rectified. Such tubes may be used in series or parallel to any desired extent in order to obtain a desired voltage, current, or output.

Mont Blanc Electric Cars.—An electric cable car service from Les Bossoms, in the Chamonix Valley, to the summit of Mont Blanc, is expected to be running next year. The line will be 12,500 ft. high, and the journey will occupy about 90 minutes.—*Daily Mail.*

The Chemical Industry.—The Association of British Chemical Manufacturers has published, under the title "Shall the State throw away the Keys?" an exposition of what fine chemicals mean to the nation. In a foreword, Sir William J. Pope, F.R.S., Professor of Chemistry in the University of Cambridge, summarises the case for the protection of the country's chemical industry by means of tariffs. He shows the importance of the industry to the nation, both in peace and war. The booklet itself expands upon this theme, giving in detail the many directions in which the chemical industry is indispensable. It is of some satisfaction to note that peace applications occupy most of the exposition.

Service Note.—Recruiting is now open for the first Territorial Battalion of Royal Engineers, to be formed under the War Office scheme for defending London against aerial attack. The new unit is designated the 10th (London) Anti-Aircraft Battalion, Royal Engineers, and the training of the battalion, which is of a scientific nature, will consist of operating searchlight projectors, engines, and sound locators. Men of a high standard are being selected, and engineering students and men with technical knowledge in electrical or mechanical engineering are particularly asked to join. Those desirous of joining should apply at the Headquarters, 10th (London) A.A. Battalion, R.E., Duke of York's School, Chelsea, S.W.—*The Times.*

New X-ray Diffraction Apparatus.—Many materials may be readily identified and their crystal structure determined with a high degree of accuracy by X-ray analysis. The apparatus described in the September, 1922, issue of the *General Electric Review* has been developed to provide a convenient means for applying this laboratory method of analysis to general crystal research and factory-control work. In the latter field, particularly, it should prove to be of great value. The article describes apparatus by which the characteristic X-ray diffraction patterns of fifteen powdered crystals may be taken at once. Each pattern is recorded on a strip of photographic film placed in a cassette which automatically holds the film on the arc of a circle of 8 in. radius, having at its centre the specimen of powdered crystal. The whole apparatus, exclusive of the switchboard, occupies a space 3 ft. in diameter and about 4½ ft. high.

The time required to obtain a satisfactory record of the diffraction pattern varies from 5 to 12 hours for substances like NaCl to 70 hours for substances like CuCl and CsI. The diffraction pattern may be interpreted directly in terms of the interplanar distances in the crystal by means of a metal scale which is calibrated in Angstrom units. If the crystal happens to belong to the cubic, tetragonal, or hexagonal systems, its structure may be interpreted directly from these interplanar distances by means of charts.

Good and Bad Works Managers.—Even in Soviet Russia, where all the industrial establishments and other works are vested in the State and conducted by so-called trusts and syndicates, it is recognised that there must be officials as well as workmen. But what can be thought of the communist mentality of the Moscow *Pravda* (Truth) in opening a prize competition to settle who are and who are not good works managers? The newspaper has invited the workmen to send full details to it concerning good and bad managers, and the information will be published. It will then be left to the participating workmen, apparently by voting, to decide who is the best and who is the worst works manager. Prizes are offered—overcoats, boots, watches, &c., and the newspaper expects that the competition will have a "special educational effect on the managers of works."

Company Liquidation.—Globe Supplies (Electrical), Ltd., 159, Pentonville Road, London, N.—The creditors interested herein were called together on November 13th, at the Manchester Hotel, Aldersgate Street, E.C. The liquidator appointed in the voluntary liquidation of the company submitted a statement of affairs which showed ranking liabilities of £562, while the assets were estimated to realise £143, or a deficiency of £419. The assets comprised book debts £63, expected to produce £43, and stock at cost £300, valued at £100. Mr. E. Russell, the liquidator of the company, said that the business was established by Messrs. Bruce & Whitehouse, the object being the purchasing of cheap German electrical goods. They carried on the business for about six months, and the company was formed in March, 1921, with a nominal capital of £300. All the shares were issued to the vendors in payment for the assets they transferred. The company had experienced considerable difficulties in getting supplies from Germany, while a sufficient turnover could not be made. Finally creditors began to press and voluntary liquidation was then decided upon. The principal asset was the stock, but it included a quantity of foreign wireless goods.

A creditor pointed out that such goods were of no use in this country as they would not meet the requirements of the broadcasting regulations.

The liquidator suggested that the creditors should appoint an informal committee of inspection to assist him in the liquidation of the company, but no resolution was passed.

The following are creditors :—

	£		£
Malleable Fittings, Ltd.	20	A. & A. Electrical Co.	11
Radiant Electrical Co.	10	General Cable Co.	12
Telephone Manufacturing Co. ...	40	Hogan & Wardrop	14
Williams, Thomas	13	Echo Battery Co.	12
Clough & Co.	35	Smith, H. W., & Co., Ltd. ...	23

Appointments Vacant.—Senior lecturer in electrical engineering (£850-£1,000), for the Royal Naval Engineering College, Keyham, Plymouth; telegraph foreman (£440), for the Government of Nigeria.

Electricity in Poplar.—On November 13th an extension of the Glaucus Street electricity works of the Poplar Borough Council was inaugurated by the Mayor (Ald. Scurr). A large party attended the ceremony, and afterwards visited an electrical exhibition, also opened by the Mayor. The new plant consists of two 3,000-kW turbo-generators, one a Fraser and Chalmers-G.E.C. set and the other a Brush-Ljungström set. Both sets operate at 130 lb. pressure, 28½ in. vacuum, and 3,000 r.p.m. They deliver 3-phase, 50-cycle current at 6,000 V. Both are standard machines. Another new feature of the station is a six-panel charging board for electric vehicles, supplied by the General Electric Co., Ltd., and erected by the Council's staff.

The former chairman of the Electricity Committee (Councillor Edgar Lansbury) presided at the ceremony, and gave particulars of the expansion of the undertaking in the past three years. He said that the number of consumers had increased from 1,863 to 2,774, the length of h.p. mains had increased by 10 miles (40 per cent.), and the l.p. distributors now had a length of 60 miles as against 48 miles. He paid a tribute to Mr. Bowden, the electrical engineer, and his staff, and asserted that although gas charges were still from 140 to 160 per cent. above the pre-war level, the price of electricity in Poplar was only advanced 50 per cent. The Mayor, in declaring the extension and exhibition open, urged his audience to take electricity in their homes and factories; once they did this they would never wish to revert to the older methods. Votes of thanks were passed to the Mayor (proposed by Ald. Hopwood, chairman of the Electricity Committee, and seconded by Mr. E. Wilson, of the G.E.C.), and to the Chairman (proposed by Mr. Bowden and seconded by Mr. Deverill, Brush Electric Engineering Co.).

The exhibition, which remains open until the 18th inst., is very representative, and the following firms are included in the list of exhibitors :—The General Electric Co., Ltd.; the British Electric Transformer Co., Ltd.; the Sloan Electrical Co., Ltd.; the Standard Electric Sign Co., Ltd.; Metropolitan-Vickers Electrical Co., Ltd.; the Western Electric Co., Ltd.; the Cable Accessories Co., Ltd.; Plant & Supplies, Ltd.; W. T. Henley's Telegraph Works Co., Ltd.; J. H. Tucker & Co., Ltd.; the B.T.H. Co., Ltd.; and Siemens Bros. & Co., Ltd.

Mr. Carrington, a local baker, has undertaken to bake bread electrically from flour supplied *gratis*, and to sell it in aid of the Poplar Hospital.

An employés' canteen, capable of cooking (electrically) daily meals for 30 persons, was also inaugurated. The cookers are of the "Tricity" type.

Ministry of Transport Rules and Orders.—The Minister of Transport has issued Statutory Rules (1922, No. 1165), dated October 11th, 1922, relating to the costs and expenses incurred in connection with inquiries or inspections made on his behalf, and superseding the Provisional Rules dated May 19th, 1922.

The Minister has also issued Statutory Rules (1922, No. 1166), dated October 14th, 1922, with respect to the confirmation of Orders under Section 7 of the Electricity (Supply) Act, 1919, reciting the procedure to be followed by persons objecting to the confirmation of an Order, and superseding the Provisional Rules dated May 31st, 1922.

Broadcasting Music.—During recent weeks interesting experiments have been conducted by the new radio apparatus which has been erected at Trafford Park, Manchester, by the Metropolitan-Vickers Electrical Co. The station's call sign is Q Z Y, and it is to become the broadcasting centre for this area.

Some of the experiments were carried out with a view to ascertaining precisely how the transmission of music by various types of instrument was affected in transmission by wireless. The assistance of amateurs who heard the transmissions was sought, and their information on technical points has been valuable in the determination of phenomena associated with different kinds of music. The services of a full orchestra were engaged by Q Z Y and transmissions on the separate instruments were made. These included the piano, violin, 'cello, harp, clarionet, bassoon, euphonium, and French horn.

On the writer's installation—a circuit employing reaction with five valves—the transmissions were heard clearly, the distance from Q Z Y being over seventy miles. With the exception of the French horn, there was no pronounced distortion which could be attributed to the actual process of transmission. The distinctive musical qualities and characteristics of each instrument were accurately reproduced, sometimes with astonishing clarity and volume.

The transmission of music by wireless is, however, a long way yet from perfection and there is a field of research which must be more definitely explored before perfection is attained. The phenomena presented in the transmission of selections by the complete orchestra, or indeed by any concerted rendering, vocal or instrumental, need careful investigation. It is well known to anyone who has frequently listened to wireless music that certain notes do not lend themselves easily to faithful reproduction, and often create unpleasant vibrations and a curious dragging or re-echoing effect. Chiefly these are strident notes, and the clashing of cymbals is particularly liable to create discord in the receiving set. On the other hand, sonorous music, such as that of the cornet and the mellifluous qualities of the harp, are rarely blemished by actual transmission.

The problem of rendering all types of music more accurately receivable in wireless is one for the radio engineer, and for the skilled musician also. The latter can do much by studying the effects mentioned, and probably, by a suitable balancing of the component parts of an orchestra during a rendering, can make reception as a whole more gratifying. It is a subject to which he might well devote time and attention, for broadcasting, necessitating, as it will, lengthy programmes of music every night, is going to create a new sphere for the services of the musical profession.

For the electrician, the chief problem at present undoubtedly is the microphone, by means of which music and speech are superimposed upon the carrier-wave generated by wireless plant. It is the only means known at present, and it has many imperfections. To begin with, it works upon a principle which, electrically, is essentially unsound, a loose contact. The carbon granules which are placed behind the diaphragm vibrate in sympathy with the modulations of sound impressed upon it, and thus incorporate speech or music with the oscillations producing radiation from the aerial. Not infrequently the granules "pack" under the influence of an excess of electrical energy, and the immediate effect is, of course, distortion in the transmission. Since the granules respond to the smallest modulation, it would seem that the notes of some instruments which are strident invariably cause packing, which lasts long enough to destroy the true quality of the note. Cannot a better means of conveying speech and music into the radio circuit be devised? In any circuit a loose contact is bad: in wireless the defects of the microphone are considerably magnified.

It is interesting, by the way, to note that experiments have been carried out with several microphones in use. This has led to decided improvement, especially in the rendering of music by more than one instrument. In a violin selection, with piano accompaniment, the piano could be heard loudly and the violin hardly at all when only one microphone was used. But when two were employed, one before each instrument, the result was a remarkable nicety of balance.—L. B. Powell.

German Electric Cable Works Destroyed.—The Gartenfeld electric cable works in Berlin, belonging to the Siemens-Schuckert Co., have been partially destroyed by fire. Several firemen were almost asphyxiated, and one has died.—*Reuter* (Berlin).

Legal.—Walsall Hardware Manufacturing Co. *v.* The Electric Components.—With reference to this case reported in our "Legal Columns" (p. 683) last week, Messrs. Electrical Components, Ltd., of Great Charles Street, Birmingham, desire it to be understood that there is not, and never has been, any connection between the company concerned and themselves.

Effect of Broadcasting on the Gramophone Industry.—At the general meting of the Gramophone Co., Ltd., on November 8th, Mr. E. T. Ll. Williams, who presided, explained that radio telephony and broadcasting in the present state of the art was in no way likely to adversely affect the company's business. Development would be watched with interest, and the future might show influence upon the gramophone industry far other than prejudicial.—*Financial Times.*

INSTITUTION NOTES.

Finsbury Technical College Old Students' Association.—This Association held its eleventh annual dinner on November 4th at the Engineers' Club, and 73 members and their guests participated. The toast of "The College" was proposed by Mr. A. Chaston Chapman, F.I.C., F.R.S., and Dr. W. H. Eccles, F.R.S., in reply, referred to the loss the College had sustained by the appointment of Dr. M. O. Forster, F.R.S., a past student of the College, to the Directorship of the Institute of Science at Bangalore, and also by the selection of Mr. Catterson-Smith to fill the chair of Electrical Engineering at the same institute. Mr. F. Gill, O.B.E., President I.E.E., proposed the toast of "The Association," and Mr. W. G. Head, M.I.Mech.E. (the President of the O.S.A.), replied, and announced that Sir Oliver Lodge, F.R.S., had consented to give the first Silvanus P. Thompson Memorial Lecture. Mr. W. M. Mordey, M.Inst.C.E. (president-elect of the O.S.A.), proposed the toast of "The Guests," remarking that they numbered among their guests the Presidents of the Chemical, Electrical, and Mechanical Institutions. Dr. Hele-Shaw, LL.D., F.R.S., briefly responded. Between the toasts a number of excellent musical items were given under the direction of Mr. L. M. Clark, A.I.C., F.C.S.

Edinburgh Telegraph and Telephone Society. — On November 7th Col. C. G. Chetwode Crawley, R.M.A., Deputy Inspector of Wireless Telegraphy to the G.P.O., lectured to the Telegraph and Telephone Society and the Edinburgh Radio Society on "Wireless Communication." He instanced the difficulties that had prevented the Imperial Wireless Chain from being accomplished, but stated that negotiations were in progress, and that shortly a definite scheme embracing the whole Empire would be in operation. The status of the radio amateur and the "broadcaster" were also discussed.—*Scotsman.*

S.A. Institute of Electrical Engineers.—According to the *Transactions* of the Institute, a sub-committee of the Council is endeavouring to collect contributions to the proposed "History of Electrical Engineering in South Africa" from electrical engineers in all parts of the country. A sub-committee of the Council has very carefully considered the "model conditions" prepared by the Institution of Electrical Engineers, London, and strongly recommends the Council to urge consulting engineers to adopt these conditions as a basic standard, and further to make use of the British Engineering Standards in their specifications. The Development of Resources Committee has been formed to assist in furthering the development of the resources of the country. There are many projects that might be brought forward in the initial stages, which, with the help of the Committee, might be brought to the point where consulting engineers are employed. It is not intended to specify the plan necessary for carrying out projects or to act as consulting engineer, but its advice may be of assistance in bringing to maturity some developments in connection with the resources of the country.

Institution of Electrical Engineers.—The Informal Meetings of the Institution commenced for the new session on November 6th with a discourse by the president, Mr. F. Gill, on the "Importance of Commercial Knowledge to the Engineer." Mr. W. E. Warrilow was in the chair, and a large gathering was treated to a stimulating address which provoked an interesting discussion. Mr. Gill said the fundamental and true function of the engineer was to apply physical laws with the least expenditure of capital and properly equip himself for the larger interpretation of the engineer's functions; it was becoming more and more important for the engineer to study the phraseology and methods of business. The engineer to-day should know the elements of accountancy, the rudiments of a balance-sheet, &c., and Mr. Gill went on to enumerate some of the commercial issues that vitally concerned the engineer. The London supply authorities were supposed to be unable to extend their business because of the imminent termination of their licences. That termination was about nine years hence, and if that period was considered too great a hindrance it was very evident how badly needed was the study of economy by engineers. Mr. Pooley opened the discussion, in which 14 members took part.

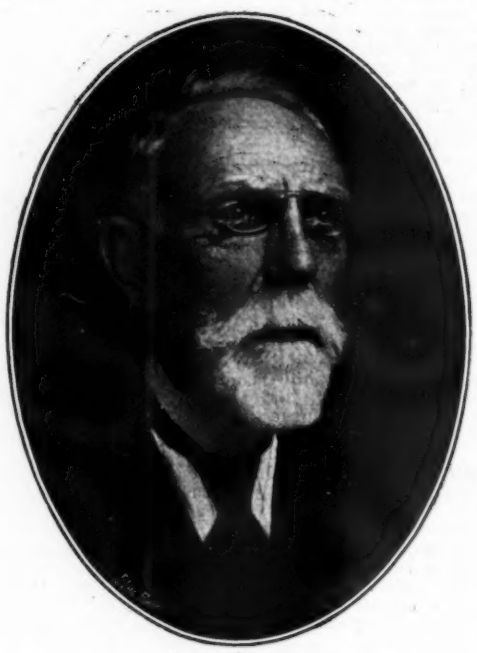
Edinburgh Electrical Society.—At the meeting held on November 27th, Mr. E. J. Taylor read a paper on "Scientific Illumination." The paper dealt with the flux distribution and efficiencies of a variety of electric light sources in common use. The author exhibited numerous diagrams and ingenious models illustrating flux in terms of water capacity, and the paper was illustrated with lantern slides giving examples of good and bad illumination of interiors.

Association of Consulting Engineers.—The annual dinner of the Association of Consulting Engineers is to be held on Wednesday evening, December 6th, at the St. Stephen's Club, Victoria Embankment, Westminster, S.W.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

M. BRILLOUIN, the President of the French Society of Electricians whose portrait accompanies this note, is one of those who have contributed to the symposium of congratulatory messages appearing in this issue. Professor Brillouin was a student at l'Ecole Normale Supérieure from 1874 to 1877, and upon leaving became an assistant master at the Collège de



PROF. BRILLOUIN,
President, Société Française des Electriciens.

France, where he remained until 1880. He subsequently occupied positions in the Universities of Nancy, Dijon, and Toulouse. In 1887 he returned to l'Ecole Normale Supérieure as Professor of Physics, remaining there until 1900, when he was appointed Professor of Physics and Mathematics at the Collège de France, a post which he still occupies. Prof. Brillouin was elected a member of the Academy of Sciences last year.

MR. E. M. DENCE, L.C.C., who has been elected Mayor of Greenwich, is a director of Johnson & Phillips, Ltd., of Old Charlton.

MR R. W. DALTON, who for the past six years has been H.M. Trade Commissioner in New Zealand, is in attendance at the Department of Overseas Trade for a brief period, and will be pleased to interview manufacturers and merchants interested in trade with New Zealand. Appointments with Mr. Dalton can be made by application to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. The reference T.G. 3,962 should be quoted in all cases.

M. PHILIPPE BEDE, who has sent one of the messages of congratulation which appear elsewhere in this issue, graduated from the Institut Montefiore de Liége in 1890, and after spending some time in Germany, joined the direction of a Belgian company whose business was the carrying out of electric lighting and power installations. Then, for ten years, he was in business on his own account as a manufacturer of glassware for lighting, with an electrical installation department. He now represents a number of French and Belgian electrical firms, and is the present president of the Société Belge des Electriciens. This institution was formed in 1883, and has now 500 members in three classes:—Educationalists and Government officials; officers of provincial and municipal administrations; and industrialists. The president is chosen from each of these three classes in rotation. The two gentlemen immediately preceding M. Bede as president were M. Emile Pierard, Director of the Telegraph Administration, and a professor at the University of Brussels, and M. Edmond Lacomble, chief of the Brussels electricity supply system.

MR. GROSSE, electricity manager under the Portrush (Co. Antrim) District Council, has tendered his resignation.

ALDERMAN MAX MUSPRATT, of The Grange, Fulwood Park, Liverpool, upon whom a baronetage is conferred in the List of Dissolution Honours, is chairman of the United Alkali Co., Ltd., founded by his father, and a director of the Automatic Telephone Manufacturing Co., Ltd. He was Lord Mayor of Liverpool in 1916-17.

Tunbridge Wells Town Council has increased the salary of the chief assistant electrical engineer (Mr. J. E. Pownall) from £496 per annum to £534.

Mr. W. Powell, for 15 years meter superintendent at the Hereford Corporation Electricity Works, has been presented, on his resignation, with two divan easy chairs.

Mr. Milton, borough electrical engineer of Maidenhead, has asked the Town Council, in view of the increasing gross profits, that 1 per cent., instead of 2 per cent., of the gross profit should be added to his salary as from April 1st, 1923. This was the amount he originally suggested, and the Electric Lighting Committee, in accepting the proposal, expressed their appreciation of the spirit shown by Mr. Milton in making the suggestion.

Mr. Joseph Toole, the Labour candidate for the Everton division of Liverpool, was, ten years ago, an employé of the British Insulated & Helsby Cables, Ltd., of which his political opponent, Sir Harmood Banner, is chairman.

Mr. S. L. Pearce, city electrical engineer of Manchester, has been elected a member of the Alpine Club. Mr. Pearce has spent many holidays climbing in the Alps, both in summer and winter, and has derived much benefit therefrom. He is also a member of the Alpine Ski Club and the Swiss Alpine Club.

Mr. Councillor Beale being unable, owing to his business engagements, to accept re-election as chairman of the Birmingham Electric Supply Committee, Mr. Alderman J. B. Burman, J.P., a former chairman, has been appointed. Alderman Burman is a member of the National and District Industrial Councils for the Industry.

Captain Arthur Angers, A.M.I.E.E., principal of the firm of Messrs. A. Angers & Co., electrical and mechanical engineers, Liverpool, was again returned as a member of the Liverpool City Council on November 1st by a large majority.

Obituary.—Mr. W. H. Smith.—We regret to record that the death took place on Sunday last of Mr. W. H. Smith, late manager of the Liverpool and Ireland branch of Simplex Conduits, Ltd. His services in the Simplex interest extended over a period of 18 years. The depot at 96, Whitechapel is now under the control of Mr. B. L. Myer, A.M.I.E.E., who, in the capacity of acting manager, relieved Mr. Smith of his duties during his recent ill-health.

Mr. J. McDougall.—The passing of a very old servant of the India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd., took place in the death of Mr. J. McDougall at his home at Forest Gate, London, E., on the 8th inst. Mr. McDougall, who was within a few days of attaining 66 years of age, entered the company's service as long ago as 1870, and was for many years in charge of the waterproofing department at Silvertown, from which position he was transferred to the company's London branch in Cannon Street in 1907.

Mr. F. W. Fox.—The death has taken place at Folkestone of Mr. Frederic William Fox, electrician, who for many years carried on business in Bank Street, Ashford, Kent. He was 68 years of age.

NEW COMPANIES REGISTERED.

Charmlyn Electrical Co., Ltd. (185,471).—Private company. Registered November 3rd. Capital, £500 in £1 shares. To carry on the business of electrical engineers, manufacturers and sellers of electrical apparatus, implements and machinery, &c. The provisional directors are: Miss E. M. I. Rollason, 20, Forthbridge Road, Clapham Common, S.W.11, secretary; A. J. Lloyd, Glastonia, Ashingdon, Essex, clerk. Secretary: Evelyn M. I. Rollason. Registered office: 16, Gray's Inn Road, W.C.

Crystophone Manufacturing Co., Ltd. (185,443).—Private company. Registered November 2nd. Capital, £1,000 in £1 shares. To carry on the business of wireless, telephone, telegraph and electric light, heat and power supply company, &c. The first directors are: N. E. Dobbin, 3, Granville Place, South Kensington, S.W.10; S. L. Forbes, 52, Fitzgeorge Mansions, West Kensington, S.W.14; J. L. Greener, 85, St. Mary's Mansions, Paddington, W.2; J. W. Fothergill, 12, Lansdown Place, Blackheath, S.E.10. Qualification: £1. Registered office: 16, Wells Street, W.1.

Broadfield Radio Co., Ltd. (185,523).—Private company. Registered November 6th. Capital, £100 in £1 shares. To acquire the business of radio apparatus manufacturers and designers carried on by R. J. Sawbridge and R. K. Coupland at Caldy Island, Pembrokeshire, as "Sawbridge and Coupland." The permanent directors are: R. J. Sawbridge, Caldy Island, Tenby, South Wales, radio engineer; R. K. Coupland, 1, The Glen, Saundersfoot, Pembrokeshire, radio engineer. Qualification: £5. Remuneration: £100 per annum, divided between them. Registered office: New Hedges, Tenby, Pembrokeshire.

Wireless Service, Ltd. (185,604).—Private company. Registered November 8th. Capital, £2,000 in 1,000 pref. shares of £1 each and 20,000 ordinary shares of 1s. To carry on the business of manufacturers of, and dealers in wireless, telegraphic, and telephonic apparatus, instruments, equipment, and accessories, &c. The first directors are:—L. M. Robinson, "Thomazines," Roydon (chairman); H. A. Reeves, 85, Talgarth Mansions, Barons Court, W.4 (manager). Qualification: 50 pref. shares. Registered office: 2, Lower John Street, Piccadilly Circus, W.1.

Waterloo Wireless Co., Ltd. (185,600).—Private company. Registered November 8th. Capital, £1,000 in £1 shares. To carry on the business of electricians, electrical engineers, dealers in wireless, telegraphic, and telephonic apparatus of all kinds, &c. The first directors are:—R. J. Kelsall, 36, Great George's Road, Waterloo, Lancs.; T. W. Craig, 3, Church Road, Waterloo, Lancs. Qualification: 100 shares. Registered office: 3, Church Road, Waterloo, Lancs.

Leo Sunderland & Co., Ltd. (185,448).—Private company. Registered November 2nd. Capital, £10,000 in 9,000 10 per cent. cumulative preference shares of £1 each and 10,000 deferred shares of 2s. each. To take over the business of electrical and general engineers carried on as "Leo Sunderland & Co." The subscribers (each with one share) are:—G. C. Pillinger, "Avening," Holland Avenue, Sutton, Surrey, electrical engineer; L. Sunderland, 1, Sheen Park, Richmond, electrical engineer. L. Sunderland is permanent managing director. Registered office: 40, Albemarle Street, W.

Milford Haven Electric Welding Co., Ltd. (185,618).—Private company. Registered November 9th. Capital, £2,000 in £1 shares. To carry on the business of electric and oxy-acetylene welders, ship builders and repairers, engineers, founders, smiths, machinists, &c. The first directors are:—D. W. Thomas, 17, Harrissmith Road, Cardiff; Edith Thomas, 17, Harrissmith Road, Cardiff. D. W. Thomas is permanent managing director, subject to holding 100 shares, with remuneration of £400 per annum and 5 per cent. of the profits remaining after 20 per cent. dividend has been paid. Remuneration of other directors, £25 per annum. Registered office: 129, Bute Street, Cardiff.

Crystor Cowl Insulators, Ltd. (185,444).—Private company. Registered November 2nd. Capital, £1,000 in £1 shares. To carry on the business of a wireless, telephone, telegraph, and electric light, heat and power supply company, &c. The first directors are: S. L. Forbes, 52, Fitzgeorge Mansions, West Kensington, S.W.14; N. E. Dobbin, 3, Granville Place, South Kensington, S.W.10. Qualification: £1. Registered office: 97, Mortimer Street, W.1.

Cardiff Electric and Wireless Supply Co., Ltd. (185,579).—Private company. Registered November 8th. Capital, £2,000 in £1 shares. To carry on the business of electricians, manufacturers, and workers of, and dealers in electricity, wireless engineers, &c. The first directors are:—S. D. Taylor, 12, Cwrtyvil Road, Penarth, Glam., electrical engineer; L. E. R. Dean, 54, Pill Street, Cogan, Glam., electrical engineer; F. L. W. Dean, 54, Pill Street, Cogan, Glam., wireless operator. Registered office: 43, Bute Street, Cardiff.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Torquay Tramways Co., Ltd.—Satisfaction to the extent of £1,400 on September 30th, 1922, of charge dated March 8th, 1911, securing £60,000.

Lyto, Ltd.—Particulars filed of £1,500 debentures authorised October 19th, 1922, charged on the company's undertaking and property, present and future, including uncalled capital, the amount of the present issue being £1,300.

British Wireless Supply Co., Ltd.—Particulars filed of £800 debentures authorised by resolutions of October 4th and 19th, 1922, charged on the company's undertaking and property, present and future, including uncalled capital, the whole amount being now issued.

Walsall Electrical Co., Ltd.—Satisfaction in full on October 11th, 1922, of mortgage dated March 7th, 1913, securing all moneys due or to become due from the company to L.J.C. and Midland Bank.

North Somerset Electric Supply Co., Ltd.—First mortgage debenture dated October 30th, 1922, to secure £25,000, charged on various properties in Portishead, Long Ashton, near Bristol, Easton in Gordano, Somerset, and the company's undertaking and other assets, including uncalled capital. Holder: Solicitor to H.M. Treasury.

British Glass Wool Co., Ltd.—Debenture dated October 25th, 1922, to secure £600, charged on Britannia Works, Lowman Road, Holloway, N., and the company's undertaking and property, present and future, including uncalled capital. Holders: Barclay's Bank.

Kartret Engineering Co., Ltd.—G. B. Manley, of 80a, Coleman Street, E.C., was appointed receiver and manager by order of court dated October 23rd, 1922.

Rawlings Bros., Ltd. (67,908).—Return dated September 22nd, 1922. Capital, £100,000 in 70,000 ordinary and 30,000 preference shares of £1 each. 50,744 ordinary and 20,685 preference shares taken up. £71,429 paid. Mortgages and charges, nil.

Royce, Ltd. (63,871).—Return dated August 1st, 1922. Capital, £170,000 in 70,000 preference and 100,000 ordinary shares of £1 each. 34,955 preference and 72,487 ordinary shares taken up. £1 per share called up on 4,955 preference and 6 ordinary and 15s. per share on 30,000 preference. £37,461 paid. £79,981 considered as paid, being £1 per share on 72,481 ordinary and 5s. per share on 30,000 preference shares. Mortgages and charges, nil.

Electric Supply Corporation, Ltd. (52,036).—Return dated July 18th, 1922. Capital, £250,000 in £5 shares. All shares taken up. £215,000 paid. £35,000 considered as paid. Mortgages and charges, £154,914.

St. Helens Cable & Rubber Co., Ltd. (87,774).—Return dated May 29th, 1922. Capital, £100,000 in £1 shares. 84,000 shares taken up. £84,000 paid. Mortgages and charges, nil.

George Moritz, Ltd. (38,158).—Return dated February 26th (filed May 5th), 1922. Capital, £10,000 in £1 shares. 9,081 shares taken up. £8,081 paid. £1,000 considered as paid. Mortgages and charges, £1,000.

CITY NOTES.

Telephone Manufacturing Co., Ltd.

In presenting the report and accounts at the annual meeting on November 7th, Viscount Chetwynd, referred to the death of Sir John Rees, in June last. Turning to the balance sheet, he pointed out that investments in installation companies had increased from £203,378 to £271,875 due to increased holdings. The principal "sundry debtors" item was £208,296, representing installation companies' current accounts. As the business of these companies was done principally on a rental basis there must continually be investment of capital; investment in a very lucrative business, but still investment rather than turning the money over and recovering it with a small profit in any immediate sense. This process must of necessity continue for a space of years, until such time as the number of installations completely written off represented a fairly large proportion of the whole. Until that time arrived the company would continually require fresh capital, and to attract the necessary capital it was essential that a really conservative policy be pursued. For this reason the directors proposed to write off certain items on the assets side to the amount of £29,158, or more than double the amount paid in dividends. With regard to the general prospects, the chairman said that until taxation was lightened industry would not recover. There was a satisfactory reduction in maintenance costs. There had been a steady increase in the business done by

their installation companies abroad, especially in Brussels. The Paris company's results were not so satisfactory, owing to the competition of cheap French instruments. The Melbourne company continued to progress, and in January last a branch was opened in Sydney, and this had already secured satisfactory orders. A new company had been formed in Madrid, and agencies had been arranged in South Africa, China, and India.

As regarded new developments, the directors had undertaken the sale of electrical fittings all over the country. The company hoped to benefit considerably by the sale of wireless telephony receiving sets. The company was a member of the Broadcasting Company, and much time had been devoted to the design of apparatus, which was now ready for the market. Any concern engaged in electrical work must of necessity have a future before it in a country so behind in electrical matters as this country.

Mr. Frederick T. Jackson, the managing director, outlined the year's progress. Two new developments were a cheap and efficient loud-speaking telephone for offices and factories, and a new automatic telephone. The "Laryngophone" had been adapted for use on ships. To meet the anticipated broadcasting "boom" the laboratory, experimental department, and drawing office, had been considerably extended, and they considered that their receiving set was equal to any competing set on offer.

Callender's Share and Investment Trust. The revenue for the year ended August 31st last was £16,006. Working expenses amounted to £1,139, and contribution to redemption fund to £1,800. £740 was written off the outstanding balance of preliminary expenses and cost of debenture stock issue, leaving £12,325. Debenture stock interest absorbs £4,141, £500 is transferred to reserve, and £1,000 allocated to corporation tax, leaving £6,684, to which is added £6,619 brought forward, giving an available total of £13,303. The directors recommended a dividend of 6 per cent. less tax, carrying forward a balance of £6,221. The debenture redemption fund stands at £21,568; investments have increased from £156,043 to £286,275. The meeting was held yesterday.

Auckland Electric Tramways Co., Ltd. Mr. C. G. Tegetmeier, presiding at the annual meeting on November 9th, said that the time was ripe for winding up the company, in view of the improved marketable value of the company's assets and its reduced liabilities. The directors, therefore, proposed to take a favourable opportunity of realising the assets and distributing the proceeds. In the winding-up the preference shareholders would receive the par value of their holding while the ordinary shareholders could look forward to not less than the par value of their shares. They had not decided upon any definite procedure with regard to the sale of the corporation debentures.

Marconi Wireless Telegraph Co. of Canada, Ltd.—Several changes were made at the annual meeting held recently in Montreal. Mr. G. C. Greenshields, K.C., of Montreal, assumed the presidency in the place of Mr. A. E. Dyment, who remains as vice-president. Mr. Henry W. Allen was appointed to the Board to represent British interests. A revision of the contract with the Dominion Government has been secured, making it more favourable to the company, and a licence has been obtained to operate a station with a 1,500-mile range at Louisburg, Nova Scotia; this will add considerably to the company's business. The Marconi Co. has secured valuable patent rights in connection with commercial radio telegraphy and telephony, and the co-operation of the Canadian General Electric Co. has been obtained in the manufacturing side of the company's business.

The Zurich Electrical Bank.—At the recent general meeting of the Zurich Bank for Electrical Undertakings, the question was raised as to whether a further reorganisation of the bank was to be expected. In reply, the chairman is reported to have stated that two points of view had been taken up in the matter. One group of priority shareholders desired to receive interest as soon as possible, while the other wished for a readjustment of the capital. The bank was no longer so much dependent upon the German mark; the engagements in marks, which still amounted to 2,290,000 fr. on June 30th, 1922, had been reduced to 450,000 fr. by the end of October. In conclusion, the chairman remarked that there could be no idea of a fresh reorganisation at the present time, as conditions had been insufficiently cleared up.

Stock Exchange Notices.—Dealings in the following have been specially allowed by the Committee under Rule 159:—

International Automatic Telephone Co.—6,825 ordinary shares of £1 each, fully paid, Nos. 208,571 to 215,395; and 5,345 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 162,974 to 168,318.

Application has been made to allow the following to be officially quoted:—

Fife Tramway Light and Power.—£250,000 7 per cent. debenture stock.

Electric Construction Co., Ltd.—Interim dividend in respect of the year ending March 31st, 1923, at the rate of 6 per cent. per annum on the ordinary shares, less tax.

Indian Electric Supply and Traction Co., Ltd.—Interim dividend of 3 per cent. on the ordinary shares.

North Melbourne Electric Tramways and Lighting Co., Ltd.—In their report for the year ended September 30th, 1921, the directors state that the company's undertakings have been sold to the State Electricity Commission of Victoria as from August 1st, 1922. When the audited accounts arrive from Australia a final balance-sheet will be prepared and submitted.—*Financial Times.*

Associated Fire Alarms, Ltd.—Profit for year ended June, 1922, £7,612, plus £6,968 brought forward. To reserve, £10,000, carrying forward £4,579. Part of the capital which is no longer represented by available assets is to be cancelled.

STOCKS AND SHARES.

Monday Evening.

Fifty years ago electricity supply shares had not come into the Stock Exchange lists. There were a good many gas issues quoted, but electricity supply was barely in its infancy, and the companies formed to deal with the new industry did not make their appearance for another fifteen to twenty years. However, the prices of some of the securities connected with the electrical railway and cable work are interesting enough, although, so far as the former are concerned, it is scarcely necessary to add that the lines were not then electrified. Consols half-a-century ago to-day, stood at 92¼, being then 3 per cents. The present quotation is 57 for the 2½ per cents. Metropolitan Consolidated at 70¾ was 15 points higher than the current quotation, but Districts were only 27½ as against the existing price of 41½.

The Brompton, Metropolitan, St. James' and Westminster Companies were registered in 1888, the Chelsea Company four years earlier. The Charing Cross came into being in 1889. The City of London and County of London started in 1891.

In the group of cable stocks, these are some of the principal prices given in the Stock Exchange Official List of November 16th, 1872:—

Company.	Price.	Company.	Price.
Anglo-American ...	130	Indo-European	15
British Australian ...	9⅝	Mediterranean Extension	6¼
British India Extended	14½		
China Submarine ...	10½	Mediterranean Extension 8 per cent. pref.	11½
Cuba, Ltd.	9		
Eastern	10¼	Reuters	10
West India & Panama...	6¼	Submarine	22
Great Northern ...	11		

Eastern ordinary in those days were shares, and the then price of 10½ was equivalent to 105 for stock, so that to-day's level shows a gain of about 85 points, without taking into account the new issues which have been made from time to time. The Stock Exchange market of those days was a small affair as compared with that of to-day, and business was limited to a handful of stocks and shares as compared with the thousands now available for the attention of investor, speculator, and—gambler.

The political events of the past week, both at home and abroad, have caused a general diminution of business in most markets, though quotations are well maintained, on the anticipation that, whichever party comes into power, it will certainly not be that of Labour. So much has been made of the Capital Levy as a menace to security of every description that it is taken for granted the country will not stand the tampering with safety which a capital levy is taken to mean. Therefore, the gilt-edged market is strong, and the Government-guaranteed stocks of the three tube railways have improved to ½ discount, the fully-paid to 93¾. A curious question has arisen with regard to Stock Exchange commission in connection with these issues. On Government stocks, the brokerage is sensibly less than that chargeable on those of railways, and buyers of the former have been urging that these new Tube debentures are really Government stocks, liable to the lower rate of commission as laid down by the Stock Exchange Committee as a minimum. The point is a nice one, worthy of argument in club smoking-rooms when Election topics become exhausted.

The Eastern group of cable stocks is dull, owing to a little selling which came about by reason of the Turks having cut one of the cables in the vicinity of Chanak. The Stock Exchange market is rather inclined to regard this with polite amusement, and, so far as can be learned, the damage is not likely to be of any great moment to the companies concerned. However, Eastern ordinary has gone back 3¼ points, Western Telegraphs 10s. and Eastern Extensions ¼. Cuba Submarines fell 7s. 6d. to 7¾. Anglo-American deferred is easier at 23¼. Allotments of the Marconi 6½ per cent. debentures, which were expected to be out on Monday, failed to put in an appearance. They are likely to be dealt in on the Wednesday in this week, and the price will probably start in the neighbourhood of 2 premium. It was said in advance that plenty of buying orders were in the market for execution as soon as dealings began. Brokers know, however, that the debentures were heavily stagged and, if this leads to selling at the outset, the premium will, of course, be reduced. At anything like 1 premium, the stock will be worth taking up by the investor.

Amongst electricity supply shares, Bromptons, Charing Cross ordinary and South Londons all show advances, which movement is in itself a convincing illustration of the manner in which the General Election is expected to run. Amongst manufacturing shares, changes in prices are inconsiderable. Callenders eased off to 2 3/16. General Electrics drooped to 17s. 6d., and the rest of the group maintains its previous levels. Whitehall Electric preference are quoted at 17s. 9d.; the debentures are 87.

Home Railway stocks show no movements as compared with the prices of last Tuesday. British Columbia Electrics have further advanced, the deferred at 77½ being 3 higher, making a gain of 6 points in as many days. Mexico Tramway Fives are 3¼ better at 74¼, and the Sixes at 46½ show a gain of four points, the bonds coming into considerable demand from Brussels and some of the foreign exchanges. Anglo-Argentine seconds weakened to 3⅞, on a little selling from Ireland on behalf of people who were taking profits on shares bought considerably lower down. The company's 5 per cent. debenture at 84 is 1¼ to the good. Brazilian Tractions lost a point at 46.

The rubber market is quiet again, and, although the price of the produce strengthened to about 1s. 0⅛d. per lb., this failed to re-galvanise the activity which was a feature of the Stock Exchange three weeks ago. The iron and steel group is also lacking in interest, the reason for public abstention being attributed to the slight doubt felt as to what is likely to be the result of the election contests in the North of England and in Wales. The Stock Exchange will be thankful when the contest is over, but a still greater measure of relief would be experienced by a settlement of the matters now in dispute between the Allied powers and Turkey.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend. 1920.	Dividend. 1921.	Price Nov. 13. 1922.	Rise or fall.	Yield p.c.
Home Electricity Companies.					
Brompton Ordinary	12	12	9½	+ ½	£6 9 9
Charing Cross Ordinary	8	9	7⅞	+ ⅛	5 16 2
do. do. do. 4½ Pref.	4½	4½	4	—	5 12 6
Chelsea	6	6	6½	—	4 12 4
City of London	14	14	2/7	—	6 15 7
do. do. 6 per cent. Pref.	6	6	20/-	—	5 4 4
County of London	8	8	1/-	—	5 11 4
do. do. 6 per cent. Pref.	6	6	1⅛	—	5 4 4
Kensington Ordinary	9	10	7½	—	6 18 4
London Electric	2½	4	3/2	—	3 17 6
do. do. 5 per cent. Pref.	6	6	5	—	5 17 1
Metropolitan	7	7	6½	—	5 7 8
do. 4½ per cent. Pref.	4½	4½	4	—	5 12 6
St. James' and Pall Mall	12	12	9½	—	6 11 6
South London	7	7	4⅞	+ ⅛	6 11 9
South Metropolitan Pref.	7	7	1/8	—	5 18 0
Westminster Ordinary	10	10	7/2	—	6 9 0
Telegraphs and Telephones.					
Anglo-Am. Tel. Pref	6	6	102	—	5 17 6
do. Def.	1½	84/6	22½	— ½	6 9 6
Chile Telephone	6	6	6½	—	4 16 0
Cuba Sub. Ord.	7	7	7⅞	— ⅛	9 0 8
Eastern Extension	10	10	19½	— ½	5 4 0
Eastern Tel. Ord.	10	10	190	—3½	5 5 3
Globe Tel. and T. Ord.	10	10	19½	— ½	5 4 0
do. Pref.	6	6	11⅜	—	5 5 0
Great Northern Tel.	24	22	28	—	7 17 2
Indo-European	10	10	35½	—	7 1 0
Marconi	25	15	2/6	—	6 9 6
Oriental Telephone Ord.	12	12	2/6	+ 1/6	*5 4 0
United R. Plate Tel.	8	8	7⅜	—	*5 16 0
West India and Panama	Nil	Nil	5/-	—	Nil
Western Telegraph	10	10	19	— ½	*5 5 3
Home Rails.					
Central London Ord. Assented	4	4	87	—	5 19 5
Metropolitan	1½	2½	55½	—	4 1 1
do District	Nil	1	41½	—	2 8 2
Underground Electric Ordinary	Nil	Nil	3	—	Nil
do. do. "A"	Nil	Nil	7/-	—	Nil
do. do. Income	3	4	80½	—	*4 12 5
Foreign Trams, &c.					
Anglo-Arg. Trams. First Pref.	5½	13½	85	—	7 11 9
do. do. 2nd Pref.	Nil	5½	3⅝	+ 1/8	7 2 0
do. do. 5 per cent. Deb.	5	5	84	+1½	5 19 1
Brazil Tractions	Nil	Nil	46	—1	8 14 0
British Columbia Elec. Ry. Pos.	5	5	77½	+1	6 9 0
do. do. Preferred	5	20/-	68	+2	*6 18 0
do. do. Deferred	5	120/-	77½	+3	*6 1 9
do. do. Deb.	4½	4½	76	+3	5 11 10
Mexico Trams. 5 per cent. Bonds	Nil	Nil	76	+3½	6 11 7
do. do. 6 per cent. Bonds	Nil	Nil	49½	—	Nil
Mexican Light Common	Nil	Nil	20½	—	Nil
do. Pref.	Nil	Nil	49½	—	Nil
do. 1st Bonds	Nil	5	65½	—	7 14 6
Manufacturing Companies					
Babcock & Wilcox	15	15	3⅞	—	4 18 6
British Aluminium Ord.	10	5	16/9	—	5 19 5
British Insulated Ord.	15	15	44/6	—	6 14 10
Callenders	15	15	2/16	—1/8	6 17 0
" 6½ Pref.	6½	6½	1¼	—	5 15 7
Crompton Ord.	10	5	15/-	—	6 13 4
Edison-Swan	10	Nil	2/-	—	Nil
do. do. 5 per cent. Deb.	5	5	64	—	7 16 4
Electric Construction	10	10	1/16	—	7 17 0
English Electric	5	5	15/0	—	6 7 0
do. do. Pref.	6	6	18/3	—	6 8 0
Gen. Elec. Pref.	6½	6½	21/9	—	5 19 6
do. Ord.	10	5	17/6	—6d.	5 14 3
Henley	15	15	2½	—	6 9 10
do. 4½ Pref.	4½	4½	4½	—	5 2 10
India-Rubber	10	—	14/6	—	—
Met.-Vickers Pref.	8	8	2/16	—	6 11 6
Siemens Ord.	10	10	35/9	—	*7 15 4
Telegraph Con.	20	20	102	—	*4 12 6

* Dividends paid free of Income Tax.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general and they may vary according to quantities and other circumstances

Tuesday, November 14th.

CHEMICALS, &c.	Latest Price.	Fortnight's Inc. or Dec.
a Acid, Oxalic per lb.	7½d.	½d. dec.
a Ammoniac, Sal per ton	£62	£1 dec.
a Ammonia, Muriate (large crystal) "	£48	...
a Bisulphide of Carbon "	...	...
a Borax "	£30	...
a Copper Sulphate "	£26 15s.	5s. inc.
a Potash, Chlorate per lb.	5d. to 5½d.	...
a " Perchlorate "	7½d.	...
a Shellac per cwt.	£17 10s.	35s. inc.
a Sulphur, Sublimed Flowers "	£9	...
a " Lump "	£7 15s.	15s. dec.
a Soda, Chlorate per lb.	3½d.	...
a " Crystals per ton	£6	...
a Sodium Bichromate, casks per lb.	5d.	...
METALS, &c.		
b Aluminium, Ingots per ton	£100	...
b " Wire per lb.	1/9 to 2/6	...
b " Sheet "	1/6 to 2/-	...
p Babbitt's Metal and Anti-friction Metal—		
Grade I per ton net	£173	£2 inc.
Grade II " "	£122	...
Grade III " "	£70	£1 inc.
c Brass (rolled metal 9" to 12" basis) per lb.	9½d.	...
c " Tubes (solid drawn) "	11¾d. to 1/-	...
c " Wire, basis "	9¼d.	...
c Copper Tubes (solid drawn) "	1/1½	...
c " Bars (best selected) per ton	£96	...
c " Sheet "	£96	...
c " Rod "	£96	...
d " (Electrolytic) Bars "	£71 5s.	10s. dec.
d " Sheets "	£145 10s.	...
d " Wire Rods "	£81 5s.	10s. inc.
d " H.C. Wire per lb.	10½d.	⅛d. inc.
f Ebonite Rod "	2/6	...
f " Sheet "	2/-	...
n German Silver Wire "	2/6	...
h Gutta-percha, fine "	12/6	...
h India-rubber, Para fine "	1/1½	...
l Iron Pig (Cleveland Warrants) per ton	92s. 6d.	...
l " Wire, galv. No. 8, P.O. qual. "	£24	...
g Lead, English Pig "	£27 10s.	...
g Mercury per bot.	£12 to £12 5s.	...
e Mica (in original cases) small per lb.	3d. to 3/-	...
e " " medium "	4/- to 8/-	...
e " " large "	10/- to 20/- & up.	...
p Phosphor Bronze, plain castings "	1/1	...
p " drawn bars and rods "	1/3	...
p " rolled strip & sheet "	1/2½	...
p " wire "	1/3½	...
o Platinum per oz.	£23	...
d Silicium Bronze Wire per lb.	1/0½	...
r Steel, Magnet, in bars "	10d.	...
m Tin, Block (English) per ton	£179 10s. to £180	£9 to £9/10 inc.
m " Wire, Nos. 1 to 16 per lb.	8/2	...

Quotations supplied by

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespeare.
h Edward Till & Co.
l Bolling & Lowe.
l Richard Johnson & Nephew, Ltd.
m P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p C. Clifford & Son, Ltd.
r, W. F. Dennis & Co.

Dance.—The annual staff dance of the Newcastle-upon-Tyne Electric Supply, Ltd., was held at the Assembly Hall, Heaton Road, Newcastle-upon-Tyne, on Friday, November 10th. The guests were received by Mr. R. P. Sloan, C.B.E., and Miss Sloan at 7.30 p.m. Amongst the guests and members of the company's staff present were:—Mr. and Mrs. C. H. Merz, Colonel W. McLellan, Mr. A. Bonnin (director), Mr. and Mrs. Norbert Merz, Mr. J. P. Gregory (B.T.H. Co., Rugby), Mr. and Mrs. H. W. Clothier (A. Reyrolle & Co.); also Mr. and Mrs. J. S. Watson, Mr. J. Cusworth, Mr. G. W. Briggs, Mr. and Mrs. H. L. Riseley, and Major and Mrs. N. H. Firmin. The Dance Committee comprised the following:—Mr. A. A. Hughes (chairman), Mr. E. Fenwick, Mr. P. V. Horler, Mr. C. S. Jowsey, Mr. W. F. T. Pinkney, Mr. M. F. Sheedy, and Mr. Cresswell (hon. secretary).

The Nobel Prizes.—The Noble Prize for Physics (1921) has been awarded to Prof. Albert Einstein, of Berlin, in recognition of his work in theoretical physics.

The 1922 prize for physics has been awarded to Prof. Niels Bohr, of Copenhagen, in recognition of his research work into the structure of atoms.

The 1921 prize for chemistry has been awarded to Prof. Frederick Soddy, Professor of Inorganic and Physical Chemistry at the University of Oxford, for his contribution to the knowledge of chemistry of active elements and his researches into isotopes.

The 1922 prize for chemistry has been awarded to Dr. Francis William Aston, Research Fellow of Trinity College, Cambridge, in recognition, among other things, of his chemical research work.—*Evening News.*

THE H.T.A. COIN COLLECTOR AND IMPULSE DIAL.

A New Telephone Call Box.

Hitherto the extension of the public telephone call cabin system to automatic exchanges has been hindered by the absence of a suitable coin-collector box and impulse dial. The result has been that where automatic exchanges cover an area in which public call cabins are needed, the authorities have been forced to install an expensive manual section to deal with this traffic.

In general coin-collector boxes in automatic areas are of the prepayment type, and it is the general practice to insert

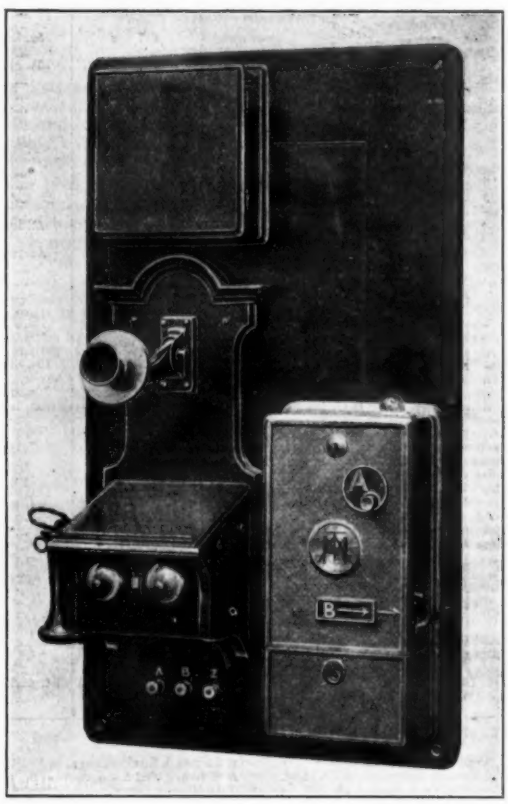


Fig. 1.—H.T.A. Coin-Collector Box.

payment in order to remove the short-circuit from the dial and enable the caller to proceed with his call. The caller has been limited hitherto by this condition, and cannot obtain the manual operator without previously inserting his fee in order to pass particulars of trunk calls, inquiries, &c., or to send telegrams.

In order to overcome this undesirable and costly limitation, a suitable coin-collector box was devised by Hall Telephone Accessories, Ltd. Next, in order to remedy the remaining defects, a simple adaptation of the standard impulse dial has been patented for use with the coin box, so that the dialling of 0 by the caller, without making payment, automatically breaks the dial short-circuit and calls the manual operator concerned with trunk, &c., calls.

The return of the dial to its normal position restores its short-circuit and allows the caller to proceed. The arrangement, of course, does not affect the normal functions of the dial and coin box, and does not allow the caller to dial for local traffic without the usual pre-payment. Its great merit is that it increases the utility of public call cabins in an automatic exchange area, without necessitating the provision of a manual section, to equal the efficiency of private lines.

This new dial is being installed by the G.P.O. in England in connection with the newest automatic exchange (which we recently had the pleasure of visiting at Fleetwood) in combination with the new coin-collector box, which is suitable for use on all systems and for any telephone apparatus where it is desired to collect payment for each call made. It is a pre-payment type of collector, and it has been installed by the British G.P.O., the French, and Swiss Post Office authorities for public service, and the Telephone Administrations of the Argentine and Belgium are introducing their first machines for trial purposes.

The collector is of very solid construction, and is purely mechanical in action; it operates with any denomination of coins through the medium of either one or more slots, and it accepts any desired number of coins of each denomination. It is, therefore, suitable for use in any country. In the case of the British machines, it is made to operate with any value of coins from 3d. to 12d. for local or toll calls, and for larger sums in the case of boxes designed to deal with distant traffic.

The accompanying illustration, fig. 1, shows the coin box, while the diagrams indicate the circuits as used by the G.P.O. in England. Fig. 2 shows the working parts and connections of the coin collector arranged for manual or automatic exchanges. Fig. 3 shows the circuit wiring used in an automatic exchange (normal position for incoming calls). For local outgoing calls, when two pennies are placed in the box, contacts 1, 2 open and remove the dial short-circuit; 3, 4 close and short-circuit the callers' transmitter. When the distant subscriber answers, the caller presses button A, and contacts 1, 2 close, while 3, 4 open. If the call is effective, the caller presses button B; contacts 1, 2 close, while 3, 4 open and 5, 6 open for an interval long enough to clear the exchange, and then close.

For trunk and junction calls the caller dials 0 *without* depositing his fee. Contacts 11, 12 open and remove the dial short-circuit; the manual telephonist answers and takes particulars of the call. When the call matures the telephonist requests the caller to place his fee in the box, and each penny deposited opens contacts 7, 8; the caller then presses button A and proceeds with his conversation.

The last diagram, fig. 4, shows the circuit wiring used in a manual exchange. The normal position of the coin box is shown, but if the last caller has received his money back, then 6 will be in contact with 5 instead of 7. Contacts 3, 4 close, and 6 moves from 7 to 5 when three pennies are inserted; contacts 3, 4 only open if money is refunded, 6 and 5 remain closed. Contacts 3, 4 open and 6 move from 5 to 7 if money is deposited. Contacts 1, 2 open momentarily when the fourth and subsequent pennies are inserted. When the short-circuit across the relay R is removed, contacts 8, 9 close,

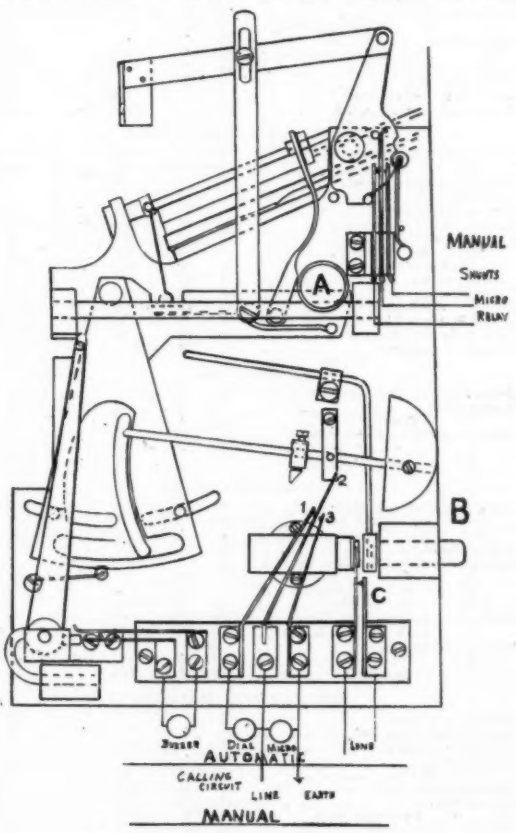


Fig. 2.—Coin-Collector Mechanism.

if the exchange operator depresses the special reversing key or answering cord. The cord circuit at the exchange answering position is fitted with a reversing key on the answering side.

The control of the payment is in the hands of the public, and the payment may always be recovered by the caller if the line is out of order. Further, any error in manipulation

is the fault of the caller, so that complaints are eliminated. It is particularly suitable for public call cabins that are not under official supervision, and is available for local and trunk calls with an indefinite number of coins of more than one denomination, the insertion and encasement of which are notified automatically and without delay to the telephonist.

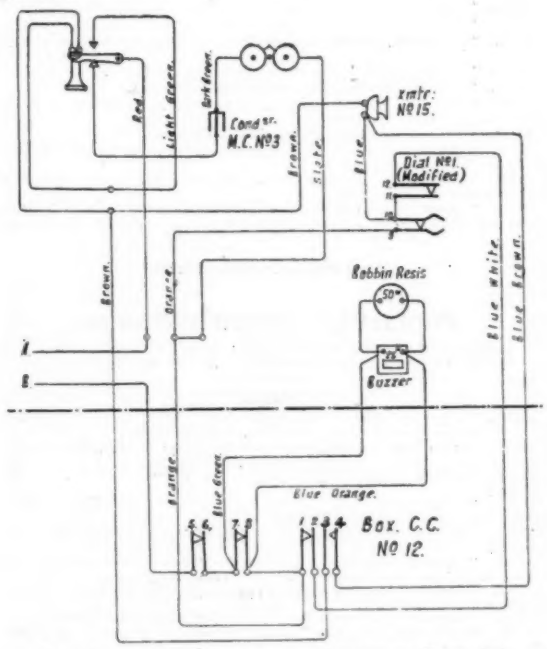


Fig. 3.—Circuit Wiring for Automatic Exchange.

Telegrams can be despatched by its means at any hour, and correct payment received for them, and it is applicable equally to automatic and to manual exchanges (both c.b. and l.b.).

It lowers the cost of each call originated through it by: (*a*) increasing the operator-hour efficiency of public instruments fivefold (French Government report); (*b*) eliminating attendants in charge of groups of public call cabins; and (*c*) increasing the cabin revenue by allowing a larger clientèle to use any busy public cabin in a given time.

Low establishment and maintenance costs are claimed for the device, which does not require any exchange or other modifications for automatic exchanges, and only a slight one for manual exchanges. It is easy to manipulate, and it rejects foreign or spurious coins. As the control of the suspended payment remains in the power of the caller up to the very instant of accepting the call (and paying in or refusing the call and re-imbursing the money), the possibility of complaints is practically eliminated. Further, as the speaking circuit is not available until the payment has been finally encased, it is impossible for the public to defraud the Administration.

Where required, a counter attachment (fitted inside the box, but with a dial visible to the subscriber) can be added to register the number of effective communications obtained, and can be used as a check on the accounts of the Telephone Administration, or to allow proprietors of shops, offices, &c., to allocate amongst tenants or departments the correct number of effective calls from a single branch exchange in the building. If a call is not accepted and the money is reimbursed to the caller, the counter does not register a call.

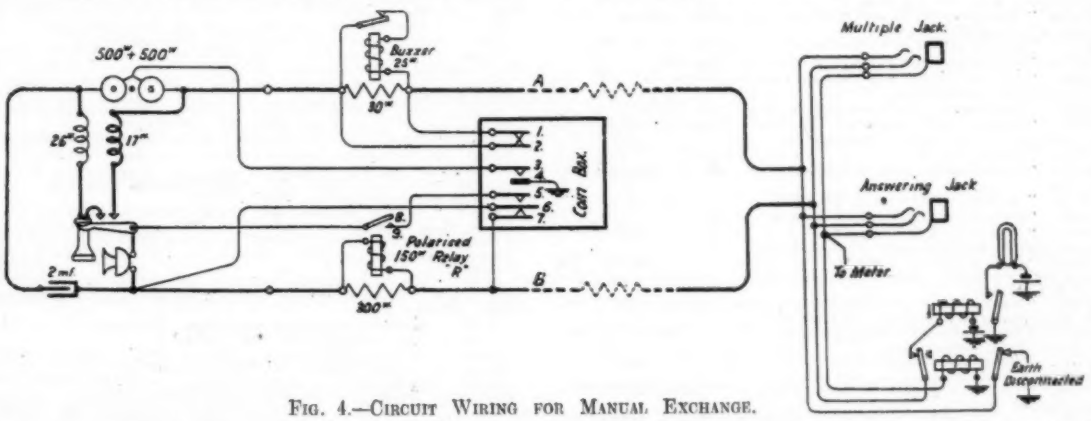


Fig. 4.—Circuit Wiring for Manual Exchange.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.—GENERAL MEETINGS.

International Rating for Electrical Machinery.

The I.E.C. method of rating (*i.e.*, 50 deg. C. rise continuous maximum rating with no sustained overload) was accepted at a plenary meeting held in 1913, and shortly afterwards the British Engineering Standards Association issued its Standardisation Rules (B. S. Report No. 72, 1917) based entirely on the I.E.C. rating, and covering all sizes and types of electrical machinery, with the exception of traction motors.

Subsequent to the war and in spite of repeated efforts, British industry has found itself unable to conform to these rules in the case of a considerable portion of the electrical machinery made in this country.

In the case of motors and generators for ordinary industrial purposes, the fact that more than 95 per cent. of British business related to machines for which the industry demanded a sustained overload (generally 25 per cent. overload for two hours) could not be ignored, and the Committee of the B.E.S.A. charged with the revision of the British Standardisation Rules was faced with the necessity of departing from the recommendations of the I.E.C.

At the express request of the British National Committee of the I.E.C., meetings of the I.E.C. Advisory Committee on Rating have been arranged to take place in Geneva, from November 20th to 26th, when the whole situation with regard to an International basis of rating for electrical machinery will be reviewed.

In addition, it is expected that matters in connection with standard pressures for transmission and insulators will be discussed at this meeting, and there will probably be an unofficial conference dealing with conditions necessary to secure public safety in the installation of lines for transmission and distribution of electrical energy.

The following members of the British Committee will be present at the meetings:—Sir Richard Glazebrook, K.C.B. (chairman of the British National Committee); Mr. E. G. Batt; Mr. A. R. Everest; Mr. Frank Gill; Major H. C. Gunton, M.B.E.; Mr. P. V. Hunter; Mr. J. S. Peck; Mr. C. Rodgers, O.B.E.; Mr. Roger T. Smith (delegate).

Delegates from the United States are now on their way to Europe to attend the Geneva meetings. Dr. Mailloux, President of the Commission, has reached Europe, and the following members of the American Committee are on the way to Geneva:—Mr. C. L. Collins; General George H. Harries; Mr. H. M. Hobart; Mr. F. V. Magelhaes; Dr. C. H. Sharp; Mr. C. E. Skinner; Dr. S. S. Wheeler.

The Indian Government will be represented by Mr. J. V. Meares. Colonel R. E. Crompton, C.B., hon. secretary of the I.E.C., will also be present with Mr. C. le Maistre, C.B.E., general secretary, and Mr. Percy Good, secretary to the British Committee.

What a Fog Costs.—According to the twenty years' average, December is London's foggiest month with ten days, October second with nine, while January and November have each a fraction under nine days of fog. To a big town fog is the most expensive of weather. First comes the enormous cost of lighting. In London a day's fog means that the gas and electric light companies have to supply gas and electric power to a value of over £7,000 in excess of the normal requirements. The loss to those engaged in surface traction is very heavy. The total loss in omnibus and tramway fares during a day of thick fog is reckoned at about £2,000. The only transportation company that profits by fog is the Underground, which gets most of the traffic that would otherwise have gone by 'bus or tramcar.—*Daily Mail.*

NEW PATENTS APPLIED FOR, 1922.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by Messrs. Sefton-Jones, O'Dell and Stephens, Patent Agents, 285, High Holborn, London, W.C. 1.

29,281. "Contacts and wiring of electric bells." L. Whiston. October 27th.
29,287. "Detector devices for weft-replenishing mechanism of looms." G. W. Shackleton and F. L. Smith. October 27th.
29,295. "Electric accumulators." P. G. A. H. Voigt. October 27th.
29,296. "Electric accumulators." P. G. A. H. Voigt. October 27th.
29,297. "Variable mutual inductances." Anode Wireless and Scientific Instruments, Ltd., and J. H. Reyner. October 27th.
29,335. "Electric switch boxes." J. Mirrey and A. Reyrolle & Co., Ltd. October 27th.
29,343. "Electro-deposition of metal." T. R. Harris. October 27th.
29,356. "Magnetic cut-outs." Rolls-Royce, Ltd., and F. H. Royce. October 27th.
29,371. "Sound amplifiers for telephones, &c." H. Ayliffe. October 27th.
29,378. "Electrodes for electric furnaces." R. Haddan (Graphitwerke Aku. Ges.). October 27th.
29,387. "Telephone systems." Automatic Telephone Manufacturing Co., Ltd. October 27th. (United States, April 5th.)
29,391. "Electric coils." B. J. Galloway. October 27th.
29,407. "Magnetometers." Eastern Telegraph Co., Ltd. October 27th.
29,431. "Radio receiving systems." British Thomson-Houston Co., Ltd. October 27th. (United States, October 28th, 1921.)
29,439. "Winding, forming, &c., devices for coils for dynamos." B. Gill. October 28th.
29,443. "Electric motor." N. Shestopal. October 28th.
29,475. "Sparking plugs." J. A. Mills. October 28th.
29,476. "Electric telegraph apparatus." F. E. Pernot. October 28th.
29,478. "Wireless receiving apparatus." H. S. Walker and G. W. Hale. October 28th.
29,492. "Sparking plug." J. Darroch and G. D. Shearer. October 28th.
29,498. "Moulds for manufacture of glass caps for electric incandescent lamps, &c." L. S. Vello. October 28th. (Spain, October 29th, 1921.)
29,499. "Moulds for manufacture of glass caps for electric incandescent lamps, &c." L. S. Vello. October 28th. (Spain, October 29th, 1921.)
29,500. "Incandescent electric lamps, &c." L. S. Vello. October 28th. (Spain, October 29th, 1921.)
29,501. "Surface wiring for electricity distributing systems." T. H. Martin-Harvey. October 28th.
29,514. "Electric vacuum tubes." Siemens & Halske Akt. Ges. October 28th. (Germany, October 29th, 1921.)
29,515. "Electric switches." British Thomson-Houston Co., Ltd. October 28th. (United States, October 28th, 1921.)
29,520. "Multiplex telegraph systems." Automatic Telephone Manufacturing Co., Ltd., and H. H. Harrison. October 28th.
29,521. "Railway signalling." Automatic Telephone Manufacturing Co., Ltd. October 28th.
29,541. "Electric power-transmission systems." A. M. Taylor. October 30th.
29,548. "Case for dry batteries, &c." F. H. Brookes. October 30th.
29,564. "Searchlights for vehicles." S. Grebel. October 30th.
29,574. "Contact rolls for electric welding apparatus." H. Imrie (F. G. Gale). October 30th.
29,580. "Variable resistance unit." W. J. Cameron. October 30th.
29,583. "Electric glow-lamp holders, &c." H. C. Tudor. October 30th.
29,584. "Thermionic valves, &c." W. J. Polyblank. October 30th.
29,602. "Motor controllers." Igranic Electric Co., Ltd. (Cutler-Hammer Manufacturing Co.). October 30th.
29,611. "Thermally-actuated device for controlling electric circuits." P. W. Baker. October 30th.
29,613. "Electric insulators for fuse carriers." W. Gee. October 30th.
29,617. "Electric flash-light." G. I. Johnson. October 30th.
29,641. "Variable inductances." British Thomson-Houston Co., Ltd., and R. C. Clinker. October 30th.
29,646. "Head-lights." I. Arthurs and R. E. Jackson. October 30th.
29,651. "Electric heating appliances." Automatic Telephone Manufacturing Co., Ltd., and C. H. Archer. October 30th.
29,657. "Radio receiving apparatus." R. E. H. Carpenter. October 30th.
29,677. "Reception for wireless telegraphy, &c." R. W. Robson. October 31st.
29,680. "Vacuum tubes." E. Y. Robinson. October 31st.
29,695. "Electric lanterns." G. B. Burnside. October 31st.
29,746. "Systems of electric distribution." F. W. Le Tall (Westinghouse Electric and Manufacturing Co.). October 31st.
29,768. "Electro-magnetic apparatus for operating relay contacts, light signal mechanisms, &c." General Electric Co., Ltd. (Hall Switch & Signal Co.). October 31st.
29,769. "Sockets for electric incandescent lamps." General Electric Co., Ltd. (Hall Switch & Signal Co.). October 31st.
29,770. "Electric luminous discharge tubes." General Electric Co., Ltd., and J. W. Ryde. October 31st.
29,775. "Signalling systems." Western Electric Co., Ltd. (Western Electric, Inc.). October 31st.
29,780. "Commutating gear of electric machines." English Electric Co., Ltd. October 31st.
29,781. "Sparking plug." G. F. Sleath and M. S. Stevenson. October 31st.
29,805. "Electric time fuses." W. Eschbach. October 31st.
29,839. "Electric driving power applied to clocks." S. J. Wise. November 1st.
29,851. "Loud-speaking telephone installations." A. Fontana and C. Hering. November 1st.
29,852. "Telephone mouthpiece." A. F. Perry. November 1st.
29,872. "Rectifying devices." A. R. Angus. November 1st.
29,876. "Electric advertising, &c., apparatus." F. H. W. Cox. November 1st.
29,880. "Multiple terminal adaptor devices for wireless telephone receiving instruments, &c." A. G. Clark and W. O. Heyne. November 1st.
29,881. "Electric switchgear." British Thomson-Houston Co., Ltd., and H. Trencham. November 1st.
29,882. "Electric propulsion of ships." British Thomson-Houston Co., Ltd., and A. A. Pollock. November 1st.
29,883. "Electric propulsion of ships." British Thomson-Houston Co., Ltd., and A. A. Pollock. November 1st.
29,890. "Electric alarm clock." W. Rausch. November 1st.
29,899. "Vehicle headlights, &c." J. Robinson. November 1st.
29,909. "Magneto-electric machines." A. Massey-Allen and R. B. North. November 1st.
29,921. "Burglar and fire alarm." D. C. Hancock. November 2nd.
29,950. "Electric connector." J. Wilson. November 2nd.
29,954. "Oscillating electric fans." A. E. Angold and A. H. Railing. November 2nd.
29,964. "Vehicle lamps." E. W. A. Webb. November 2nd.
29,982. "Current collectors for dynamo-electric machines." J. H. St. H. Mawdsley. November 2nd.
29,988. "Contact spring sets for telephone systems, &c." W. E. Goodwin and Siemens Bros. & Co., Ltd. November 2nd.
30,026. "Electrical heating apparatus." O. Mozzali. November 2nd. (Italy, November 3rd, 1921.)
30,029. "Electric fittings." British Thomson-Houston Co., Ltd., and H C. Wheat. November 2nd.
30,056. "Electro ignition devices for internal-combustion engines." R. Bosch Akt. Ges. November 3rd. (Germany, April 28th.)
30,073. "Mine signalling visual indicator." R. S. Gardner. November 3rd.
30,075. "Electric switches." C. C. Garrard, A. H. Railing, and W. Wilson. November 3rd.
30,082. "Electric switch plugs." R. Crust. November 3rd.
30,085. "Means for deadening noise of tramcars." A. Loré. November 3rd.
30,095. "Electric cable joint boxes." J. C. Lee. November 3rd.
30,102. "Incandescent electric lamps." R. Andersson. November 3rd.
30,113. "Telephone exchange systems." G. Deakin and Western Electric Co., Ltd. November 3rd.
30,115. "Electric fuses." W. Clark. November 3rd.
30,116. "Electric switches." W. Clark. November 3rd.
30,139. "Electro-magnetically-operated horns." H. W. F. Ireland, J. Lucas, Ltd., and O. Lucas. November 3rd.
30,145. "Electric switches." P. H. Waller. November 3rd.
30,147. "Colour control systems for projectors." British Thomson-Houston Co., Ltd. November 3rd.
30,149. "Directional submarine sound receivers." Signal Ges. November 3rd. (Germany, October 9th.)
30,150. "Mixed internal-combustion and electric propulsion systems." Sulzer Frères Soc. Anon. November 3rd. (Switzerland, August 12th.)

PUBLISHED SPECIFICATIONS.

The numbers in parentheses are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

1921.

10,285. "Start-stop printing telegraph system and apparatus therefor." E. C. R. Marks (Morkrum Co.). April 7th, 1921. (187,247.)
13,288. "Thermionic devices." Ges. für Drahtlose Telegraphie, Dr. A. Meissner and W. Fitze. May 10th, 1921. (187,261.)
13,714. "Electrical controlling devices." M. Walker. May 17th, 1921. (187,264.)
16,271. "Interference tubes for phonographs and telephones." M. E. Wolvekamp. June 13th, 1921. (187,276.)
17,440. "Electric lamp holders." H. B. Prentice. June 27th, 1921. (187,285.)
18,364. "Outside containers or boxes of electrical storage-batteries or accumulators." I. E. Kohlmeyer. July 6th, 1921. (187,287.)
18,707. "Electric measuring apparatus of the moving-iron type." Da and Dutilh (firm of). March 31st, 1921. (177,757.)
18,934. "Electric light fittings." J. Scott. July 13th, 1921. (187,302.)
18,999. "Indirect lighting unit." A. J. Stephens (W. A. Dorey). July 14th, 1921. (187,305.)
19,010. "Water-tight interlocked electric switch and plug-and-socket connection." J. Scott. July 14th, 1921. (187,306.)
19,145. "Switches for electric circuits." A. West & Co., Ltd., and V. Breeze. July 15th, 1921. (187,316.)
19,163. "Electric motors for the direct driving of slowly-rotating shafts." C. Lott. January 17th, 1921. (174,138.)
19,260. "Devices for testing the insulation of electric three-phase high-tension conductors." F. Brennecke. July 16th, 1921. (187,322.)
19,543. "Electric-distribution systems." British Thomson-Houston Co., Ltd. (General Electric Co.). July 20th, 1921. (187,337.)
19,661. "Light-ray projector." H. Sefton-Jones (W. A. Dorey). July 21st, 1921. (187,340.)
20,718. "Regulation on long-distance electric transmission lines." A. M. Taylor. (Addition to 170,619). August 4th, 1921. (187,356.)
20,850. "Power transmission mechanisms of electrically-driven vehicles." W. E. Moore. August 5th, 1921. (187,360.)
21,105. "Directional wireless apparatus." N. F. S. Hecht. August 9th, 1921. (187,363.)
21,564. "Glass-working machines." British Thomson-Houston Co., Ltd. (General Electric Co.). August 13th, 1921. (187,374.)
21,624. "Alternating-current dynamo-electric machines." R. Townend, J. A. Kuyser and Metropolitan-Vickers Electrical Co., Ltd. August 15th, 1921. (187,377.)
23,760. "Electric switches for wireless-signalling apparatus." H. R. Rivers-Moore. September 6th, 1921. (187,415.)
24,693. "Thermal switches for electrically-heated apparatus." Aktiebolaget Birka Regulator. September 30th, 1920. (169,696.)
26,549. "Electro-magnetic brakes." Igranic Electric Co., Ltd. (Cutler-Hammer Manufacturing Co.). October 7th, 1921. (Addition to 162,145.) (187,439.)
26,887. "Current-transmission devices for ball-bearings in electrically-driven rail vehicles." J. Schmid-Roost Ball-Bearing Works, Ltd. November 6th, 1920. (171,366.)
26,901. "Electricity measuring instruments." H. Lucas, E. J. B. Danks and O. A. Miller. October 11th, 1921. (187,441.)
28,016. "Electric railway motor control systems." Metropolitan-Vickers Electrical Co., Ltd. November 5th, 1920. (171,685.)
28,123. "Sparking-plug for explosion motors." A. O. M. Lofgren. October 23rd, 1920. (170,596.)
28,659. "Thermionic valve transmitters for wireless signalling." B. H. N. H. Hamilton. October 28th, 1921. (187,457.)
29,269. "Compression device for electric transformer windings." Allmanna Svenska Elektriska Aktiebolaget. March 8th, 1921. (176,754.)
29,446. "Electrically-driven vehicles." G. Meyfarth and Soc. Anon. des Ateliers de Secheron. November 30th, 1920. (172,288.)
30,150. "Motor lamps." E. H. Venables. February 9th, 1922. (187,476.)
33,121. "Sparking plugs." J. E. Temple. December 9th, 1921. (187,501.)
35,078. "Earthing choking coils or voltage transformers for high voltages." E. Pfiffner. January 5th, 1921. (173,759.)

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2,589. "Electric sound-producing horns." T. S. Rogers. October 20th, 1921. (Divided application on 27,822/21.) (187,531.)
4,270. "Electric switches." Metropolitan-Vickers Electrical Co., Ltd. February 14th, 1921. (175,629.)
9,296. "Means for attaching conductors to electric insulators." G. V. Twiss. March 31st, 1922. (187,547.)
15,049. "Telephone systems." Automatic Telephone Manufacturing Co., Ltd. July 6th, 1921. (182,779.)
15,201. "Electrical transformers." Metropolitan-Vickers Electrical Co., Ltd. June 3rd, 1921. (181,011.)
17,819. "Loaded signalling conductors." Western Electric Co., Ltd. August 16th, 1921. (184,781.)
18,567. "Construction of electrode for electric welding." A. E. White (Elyria Iron and Steel Co.). May 18th, 1921. (Divided application on 13,961/21.) (Patent of addition not granted.) (187,561.)
18,587. "Metallic vapour lamp." Dr. P. Eversheim. July 10th, 1920. (Divided application on 166,144.) (182,807.)
19,742. "Transmitting instrument for start-stop printing telegraph system." E. C. R. Marks (Morkrum Co.). April 7th, 1921. (Divided application on 187,247.) (187,562.)
19,743. "Receiving instrument for start-stop printing telegraph system." E. C. R. Marks (Morkrum Co.). April 7th, 1921. (Divided application on 187,247.) (187,563.)